RECLAIMING THE MAIMED

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Reclaiming the Maimed

A HANDBOOK OF PHYSICAL THERAPY

BY

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INTRODUCTION

In the following pages I have endeavored to put in small compass a description of the means that have been potent in putting back into active military service nearly half of those men wounded or otherwise disabled in action, who had climbed with decreasing speed the uphill road to recovery that too often halts at permanent invalidism.

This work is founded on an experience of over a year as Medical Officer, in charge of the "Command Depot" at Heaton Park, Manchester, and as Inspector of similar institutions for the treatment of convalescents, founded by the War Office throughout the British Isles. This experience was added to by a tour of inspection of the Canadian Convalescent Hospitals, established by the Military Hospitals Commission, for the purpose of standardizing the teaching and practice of physical therapy.

My thanks are due, and gladly given, to Sir Alfred Keogh, G.C.B., Director General of Medical Services, whose foresight and energy made this work possible in Britain and whose sympathetic support helped it over the difficult stages of organization, to proved efficiency. To the practical common sense and unbounded activity of Sir Robert Jones, K.C.B., Inspector of Military Orthopedics, who founded the chain of orthopedic centers, to which curative workshops are attached, I owe much, received during our association in the inspection of hospitals and camps. To Doctor R. Fortesque Fox I am indebted for assistance in establishing the Hydro at Heaton Park. I wish to thank Captain A. E. Barclay, R.A.M.C., for invaluable help on the first appliances used for reëducation at Heaton Park, of which

more than thirty sets have already been distributed throughout Great Britain and India, and also my assistants, Doctor H. S. Seeuwen, and Doctor Frank Radcliffe, for loyal and efficient service at all times.

To Sir James Lougheed, K.C.M.G., President of the Military Hospitals Commission, now the Invalided Soldiers' Commission, who showed his appreciation of the importance of physical therapy by ordering an inspection and report on the subject, I owe the opportunity of studying the conditions in the Canadian Military Hospitals, and also to the Superintendent, Colonel Alfred Thompson, M.P., C.A.M.C., and to the Director, Mr. S. A. Armstrong, I am a willing debtor for many services cheerfully rendered.

I cannot close without reference to the experimental work of E. A. Bott, Ph.D., and his staff at the reëducation center, Hart House, University of Toronto. Many of the standard appliances adopted by the Military Hospitals Commission for the reëducation of disabled muscles owe much to their study and suggestions.

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CHAPTER I

THE calamity of war has been necessary to startle the profession into a realization of the wide field that should be occupied by physical methods in the treatment of disease. The sporadic wounds that peaceful life produced have been multiplied in our military hospitals into groups, the exception has become the ordinary; torn and mangled bodies have had to be patched and remade, and functions lost or weakened gradually coaxed back toward the normal, by means hitherto despised, or ignored by too many physicians and surgeons.

Until the outbreak of the war these means were in the hands of a few enthusiasts in the profession, or were exploited by that motley army of camp followers who had entered the highway of medical practice, not by the gate, but through holes in the wall, puffed up by the importance of partial knowledge, or making fact bow to some preposterous theory.

Old conditions have come up with new names, and new conditions have had to be met by a rearrangement and application of old means. We must reconsider at this time the whole field of physical therapy as applied to and affected by the great war.

This Cinderella of the therapeutic family may be said to include the application of Electricity in its many forms, Radiant Heat, Water, Hot and Cold, Massage, Passive Movement, Muscular Reëducation, and Gymnastic Exercises.

APPLICATION OF PHYSICAL THERAPY. — 1. Injury to peripheral nerves, all the way from bruising of a nerve trunk to its destruction and restoration by surgical means.

These cases are accompanied by weakness, or paralysis, muscular wasting, and contractures. They are treated by wet or dry heat to exalt the local circulation, support in proper position by splints to prevent the overstretching of weakened

FIG. 1. — Bullet wound of the arm followed by ulnar paralysis with wasting.

muscles, and the resultant permanent contraction of those that are unimpaired, galvanic, and afterward faradic, stimulation to the affected muscles, massage to keep up or improve their nutrition, passive movement to prevent contraction and limitation of the normal range of the joint, progressive active movement, joint by joint, to bring back and strengthen voluntary power; ending with gymnastic and vocational training *for skill to fit the patient* to take his place in civil life again.

2. Scar tissue, either in preparation for, or after operation. A bullet may leave a small entrance scar, but its course through the tissues may leave great areas in which muscle, fascia, tendon, nerve, periosteum, and skin are matted together in one confused, distorted mass, leaving the limb blue, clammy, moist with continual perspiration, and so painful that the patient winces at the slightest touch — even after amputations the sensitive nerve endings caught in the scar of the operation are among the most troublesome conditions of war surgery.

FIG. 2. — Bullet wound of the back. Entrance at first dorsal level; exit at seventh dorsal.

FIG. 3. — Painful stump following explosion of hand grenade.

Such wounds are treated by the warmth of the whirlpool bath, which in twenty minutes changes the cold purple of the painful hand into a warm crimson, and enables the masseur to stroke, knead, and move a joint in a way that no amount of persuasion would have made tolerable without it.

The hastening of repair in these scars by diathermy and ionization and the stretching of beginning contractures by careful manipulation, taking care to avoid the breaking down of scar tissue in course of organization, are among the triumphs of these methods.

FIG. 4. — One hundred and thirteen wounds from the *explosion* of one shell.

3. Old septic wounds, long since healed, are frequently persistently painful, and a focus of infection may be discovered. It is a frequent experience to find part of a long scar become painful, then red, and finally to see a sequestrum of bone extruded that would have lain for months a source of trouble without the stimulation of heat and massage to hasten its removal. Naturally such cases need most careful supervision, and a rough and unskilled operator may easily do more harm than good. Electricity, heat, and massage have a most important place in softening extensive scar tissue and making the work of the surgeon easier.

4. In all post-operative conditions, the cure must be completed by physical means.

It is not enough to break down an adhesion, or restore a joint to potential usefulness. Its nutrition must be improved, and the patient must be taught to use it. Even if it is possible to move it passively throughout its whole range, the cure is not complete till the patient can do this himself with power and skill. He must be taken through a course of re-education beginning with simple single movements, and advancing to those harder and more complex. Devices for this purpose must be designed and employed until he can go through the more complicated actions of the craft he may elect to practice.

5. Functional neuroses, which take the form of palsies, contractures, loss of sight, speech, or hearing, areas of anæsthesia or hyperæsthesia, show many dramatic cures by physical means. Contractures slowly stretched and kept in place by splints, systematically massaged, and exercised by the faradic battery, where voluntary movement cannot be obtained, can be brought back to usefulness by a combination of hypnotism, suggestion, encouragement, and the gradual replacing of them by voluntary movement. The operator here must be both priest and physician, for the mental is even more important than the physical treatment

and these very real conditions, beyond the patient's control in most cases, require persistent and intelligent treatment sometimes over long periods of time.

6. The conditions variously grouped under the name "Shell Shock," which vary all the way from minute hemorrhages into the brain substance, caused by concussion, to fear and intolerable weariness, must be treated by this means. A soldier begins to move his head rhythmically, twitch his arm, or clutch at the sound of a shell, and the regimental surgeon, if he is wise, sends him back to the rest camp for a week or two. If he is kept until the inevitable smash comes, his recovery will be a matter of months at best, and he is usually out of commission permanently. Tremors coarse and fine, up to the point of a general convulsive seizure, rhythmical movements when the man is spoken to and calming down when he is left alone, are characteristic.

FIG. 5. — Functional paralysis of abdominal muscles following crushing injury in a trench.

Many of them are martial misfits, never built for the noise and stress of modern warfare, and rapidly going to pieces under it, with a history of nervousness and frequently with enlarged thyroids, rapid pulse, and prominent eyes. All these conditions call for rest and sedative treatment, at first the continuous bath at skin temperature, an hour's rest in bed daily, and the substitution of gentle massage and electricity for active movement, with later a gradual

increase of exercise beginning with a slow walk, and ending with gymnastics, games, and vocational training.

7. The "soldier's heart" is but a manifestation of overstrain. The rapid pulse and breathlessness, the enlarged thyroid, all show the nervous origin of the condition so familiar to medical officers as D. A. H. In these cases the faradic or high frequency current through the thyroid, the sedative bath, gentle massage, and rest quickly reduce the rapid pulse rate and allow him to bear, without damage, an increasing load of work in the form of light gymnastic exercise and walking.

8. The debilitated, whether from typhoid or dysentery, are built up again, hardened, and made ready for service by graduated exercises of effort like gymnastics, and of endurance like walking, until they can bear the load of work to which they were formerly accustomed.

9. The place of physical remedies in the treatment of sprains and fractures, in rheumatism and gout, in flat foot and other postural defects, need not be discussed here. Enough has been said to show that most of the men that fill our war hospitals, command depots, and convalescent homes must depend in great measure for their present treatment and future prospects on the masseuse, the practitioner of electro- and hydro-therapy, the physical instructor, and the teacher of vocational training.

The progress of treatment usually begins with preparation by heat, either wet, dry, or produced by electricity, on through stimulation of nutrition, by massage, and passive movement, then to simple exercise taken voluntarily, and finally to skilled movements by gymnastics, games, and handcrafts.

Cases naturally divide themselves into two classes, those requiring *general* treatment and those requiring local treatment; and in planning a Department of Physical Therapy this should be kept in mind.

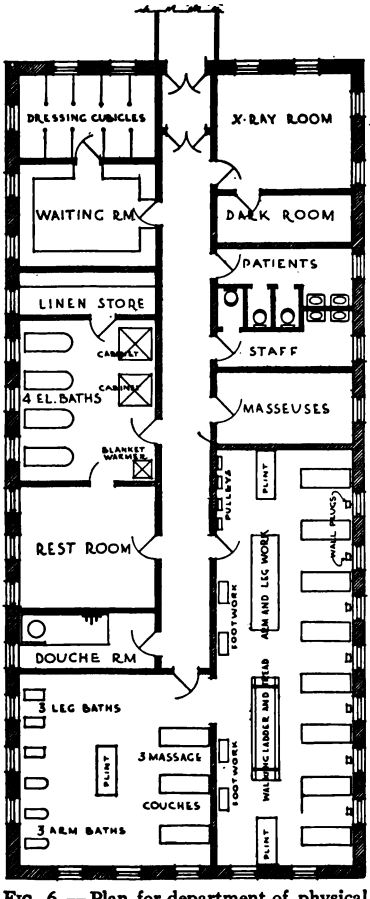

FIG. 6.—Plan for department of physical therapy in a military hospital for convalescents.

1. By general treatment we include the douche, the full bath, the cabinet for light and heat and general massage. For all these the patient must undress and after them he should rest. Make ample provision for a waiting and dressing room with linen closet and blanket warmer. A patient with irregular, irritable heart, or suffering from shell shock, requires sedative treatment and quietness. His bath should not be in the same room with the douche, where there is continual traffic, talking and splashing.

The rest room should be conveniently placed to both douche and bath rooms. It should be darkened and patients should be left quiet and undisturbed for an hour or more after treatment, well wrapped up on comfortable couches.

2. For local treatments the patient usually bares an arm or leg only, and provision for dressing

need not be so elaborate. They pass in a continuous stream through the treatment rooms from bath to table or couch and on to apparatus and the gymnasium.

The floor plan should be arranged to keep these two streams of patients apart. For massage, electricity, and corrective exercise, one large room is to be greatly preferred to several small ones. There is no great objection to having arm and leg baths at one end of it. The head masseuse can supervise her work much better, it is more cheerful for the patients, and any required privacy can be secured by screens. Plugs should be inserted at short intervals around the wall to connect with the lamps, photophores, and electrical appliances. This gives flexibility to the equipment, and allows the setting up and application of radiant heat, galvanic, or sinusoidal current wherever it may be most needed. Each masseuse should have her own couch or table, and the plinth and appliances for corrective gymnastics and re-education should be placed in a zone down the center of the room.

In addition to the case history which follows the man wherever he goes, a card should be issued for him when he starts treatment. This card should contain a brief case history, diagnosis, and proposed treatment. The masseuse in charge of the case should enter on it the measurements of movement, strength, and other notes of progress. It should be kept by her, ready for inspection by the medical officer, and when the case is finished, it should be used as a store-house of accurate information from which to make notes for the case sheets. The card should then be filed in the records of the Department.

When some such plan is not used, important facts are sure to be lost or to remain unrecorded. The card serves as a constant reminder, both to the medical officer and the masseuse, and in dealing with large numbers of patients, it is a great time saver as well.

CHAPTER II

MEDICAL ELECTRICITY

GALVANISM, IONIC MEDICATION

THE subject of electricity is approached by many medical men in an attitude of apparent contempt but of very real apprehension. To this succeeds an increasing confusion of ideas ending in a final collapse, as the intricacies of the various currents or "modalities" are exposed to his astonished gaze, and their conflicting claims set forth. It is in the hope of saving the reader from some of the quagmires through which I have floundered that I will endeavor to bridge some of the most obvious of the pitfalls which beset the unwary traveler and prevent him from appreciating the real value of this therapeutic agent.

Electricity is produced by chemical action, by induction, and by friction, all these forms being used in medical treatment.

OBJECT. — The object of electrical treatment is (1) to produce heat either on the surface or in the tissues and so to induce hyperæmia and absorption of inflammatory products, (2) to cause absorption of drugs, (3) to stimulate nerves and so produce muscular contraction, (4) to cause muscular contraction by chemical action on the muscle tissue itself, and (5) to soothe and alleviate pain.

CONTINUOUS CURRENT. — The continuous current is produced by chemical action. If we take an earthen vessel

containing dilute sulphuric acid and place in it a rod of zinc and a rod of copper, there is a transfer of electricity from the zinc to the copper. If a connecting wire is placed between the copper and the zinc, electricity will flow along it back to the zinc in order to reëstablish the equilibrium, and this flow of electricity will cause bubbles of hydrogen to form at the copper rod, as may be readily observed. It keeps paying back its debt to the zinc. The part of the plate to which the wire is attached is called the pole. It is quite logical then that the copper should be called the plus pole (anode) and the zinc the negative (cathode), the part which is immersed being called the plate and the fluid the electrolyte.

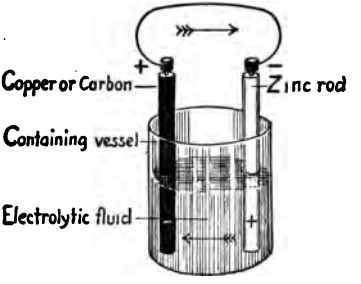

FIG. 7. — A galvanic cell.

There are many influences which vary the strength of the current induced by the action of this simple cell just described.

If the hydrogen bubbles are allowed to accumulate on the copper plate, the layer becomes thick and acts as a barrier so that the current is weakened; and finally when the layer of gas becomes thick enough, the current is completely blocked. This is called polarization, and the cell may be depolarized by wiping the bubbles away.

The cell just described has been, in many cases, replaced by the dry cell in which the electrolyte is a solid instead of a fluid, but the chemical action is in every case substantially the same.

THE VARIATIONS IN CURRENT. — To understand the *relationship between* voltage, resistance, and volume,

may take a simple illustration. Imagine a cistern full of water placed at a high level. If it has no outlet, the water remains at rest, but with high potentiality for power. If a pipe be arranged leading from it to a low level tank, the water will flow through it to the lower tank with a certain force. This may be compared to the current flowing from the positive to the negative pole. The strength or force of the stream is directly dependent upon the amount of difference in the two water levels. The pressure of this stream is comparable to the *voltage* of the electric current. As soon as the high level cistern is emptied, the flow of water will cease, and it is only possible to have a continuous flow by pumping the upper cistern full. Such a pump may be compared to an electrolyte which keeps continually charging the positive pole and taking from the negative pole. The *resistance*, measured in ohms, in the wire or conductor and in the tendency to polarization as already described, resembles the slowing of water by the friction of the walls of the pipe. The volume of current (measured in amperes) will vary, according to the resistance and the caliber of the carrier. The greater the resistance, the smaller will be the resultant current, just as a narrow and tortuous pipe will allow less water to pass through it than a large, straight one. To get a greater amount of water, you would have to reduce the resistance by using a bigger pipe or straightening it, or else raise the level of the upper cistern to increase the pressure, and the resistance is reduced as much as possible in every circuit by the use of good conductors. The following electrical units have been adopted.

A *volt* is the amount of electromotive force generated by a Daniell's cell, which is standardized. While this is only approximately correct, other cells are always measured with this for comparison.

Currents for lighting purposes usually consist of either 110 volts or 220 volts. For medical purposes, the voltage

is usually very small in comparison, except in static and high frequency machines, where it rises to 1000 or more with very small volume.

The unit of resistance (the ohm) is that offered by a copper wire 1000 feet long, and $\frac{1}{10}$ inch in cross section. With this, other resistances can be measured. The resistance of the human body with a wet skin has been quoted as between 1000 and 300 units, or *ohms*.

A unit of current is called an *ampere*. It is the quantity of electricity which an electromotive force of one volt will cause to flow through a resistance of one ohm in one second.

The ampere is too large a unit for medical purposes and a thousandth part is employed as the most convenient unit. It is called a milliampere.

It will thus be evident that with resistance remaining constant, doubling the voltage doubles the current, or "The current varies directly as the voltage." If the voltage remains constant, then doubling the resistance halves the current; or halving the resistance doubles the current, or "The current varies inversely as the resistance."

The current can be varied in any of these respects by combining cells in series or in parallels. The joining of two

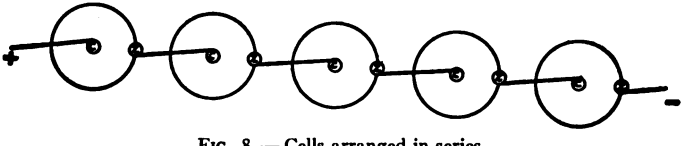

FIG. 8. — Cells arranged in series.

cells negative to positive forms a battery. If they are joined in a series by means of connecting wires, it is as if you added a number of pumps to a pipe containing water. The result will be an enormous increase in the force in which the water is driven along, or, in electricity, an increased voltage

but the volume will not be correspondingly increased because much of the effort will be spent in overcoming the increased resistance. Currents with high voltage and small volume are used in medical practice for diathermy, where the resistance of the tissues is shown by the production of heat. If, however, cells are joined in parallel, it is as if we had a common reservoir which we wished to fill with water and a number of pumps, not joined one after the other, but each acting independently and pouring its own stream into the reservoir. The force of the flow will be small (that of one pump), but the volume will be great in a given time.

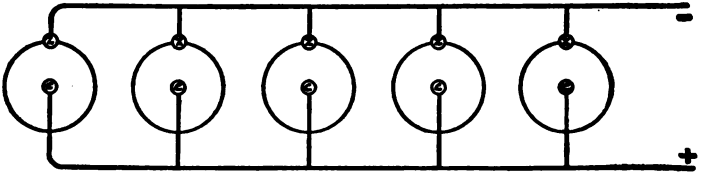

FIG. 9. — Cells arranged in parallel.

In other words, the parallel grouping gives a voltage equal to one cell only, but the internal resistance being reduced, the current or ampereage is increased, and we have a large current flowing at a low voltage. This is the current used for the cautery and diagnostic lamps.

A galvanic battery consists of a suitable box containing cells and a switchboard to which they are connected by conducting cords of copper wire. On this switchboard are found the terminals to which the connecting cords are attached, leading to the electrode by which the current is applied to the patient, a switch to turn the current off and on, a milliamperemeter to measure it, a metronome or rheotome to interrupt it, and a rheostat or cell collector to increase or decrease the amount and strength of the current.

The binding screws or terminals are marked plus for the positive pole or anode and minus for the negative pole or cathode.

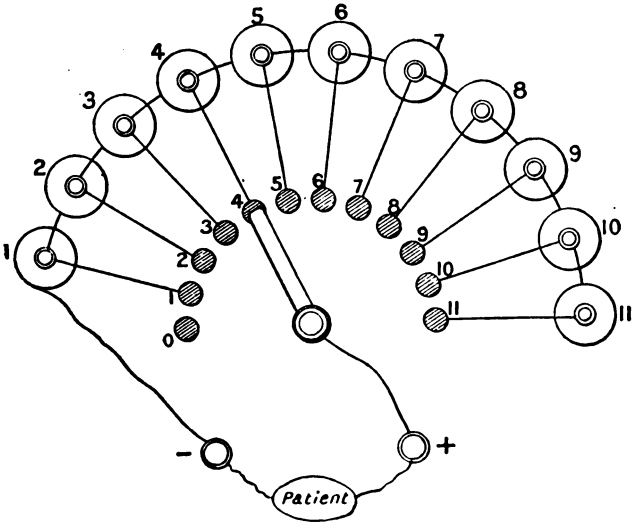

FIG. 10. — Cell collector.

EFFECT OF GALVANIC CURRENT UPON THE MUSCLES. — A constant current produces no contraction when flowing with uniform strength through the body; but if it is suddenly cut off or broken, a muscular contraction is produced. If it is suddenly switched on (or made), a muscular contraction is also produced. These contractions are not equal either at the break or make of the current or at both poles, for the contraction at the cathode when a current is turned on is much the most active. Various devices are used to interrupt the *galvanic* current and produce these contractions

The chief devices are the reversing switch and the metronome. The simplest form of metronome is a wire rhythmically introduced and withdrawn in a cup of water; the strength of the current varies with the depth of immersion as it rises and sinks, so that the patient will receive a current of constantly varying intensity, rising and falling in waves. It is also possible to reverse it by the use of the pole changer and so to have the direction of the current change at each insertion. "Sinusoidal" is the term applied to a current which starts at zero, comes up to its

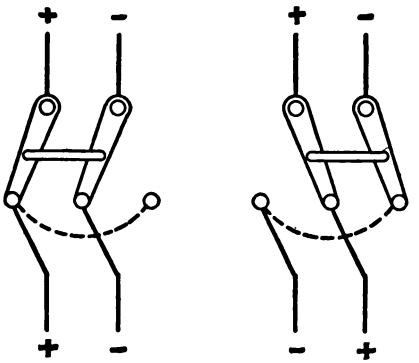

FIG. 11. — Reversing switch.

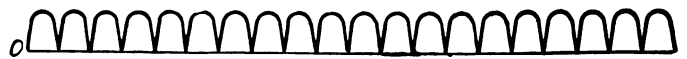

FIG. 12. — Current varied by the metronome.

full strength on the positive side, of the line, and goes back to zero, forming what is called a true sine curve. It then

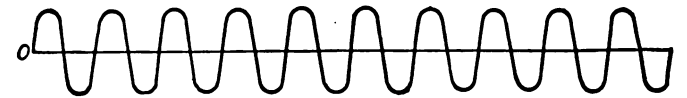

FIG. 13. — Sinusoidal current from the metronome and pole changer.

repeats this on the negative side, so that there is an alternating current positive and negative, rhythmical in character.

This is found to be very much less irritating and painful than if the current were opened and closed abruptly, and in consequence this current is the most popular for general use in muscular stimulation.

GALVANOMETER. — This is an instrument for measuring the amount of a constant current. It is graduated in milliamperes for medical instruments, and the deflection of the needle records the strength of the current, the amount being recorded on the scale.

FIG. 14. — Milliamperemeter.

Very different effects are produced on the tissues by the electric current at the anode and the cathode. The direction of the current may be determined easily by litmus paper. A strip is laid upon a wet surface and the current is led through it. Blue litmus paper turns red at the anode, where acids are produced, and red litmus paper turns blue around the cathode, where alkalis are produced. There are other tests, but this is perhaps the simplest.

PHYSIOLOGICAL EFFECTS; ELECTROTONUS. — The irritability of the nerve and muscle through which a constant current is passing is altered as follows: In the region of the anode, irritability is decreased and muscular contraction is less readily obtained, the circulation is lowered, sensation is decreased, and pain is deadened. In the region of the cathode, muscular contraction is more readily obtained, sensation is increased and there is hyperæmia and reddening of the part.

CHEMICAL. — The human body contains a large amount of sodium chloride in solution. The constant current splits salts into their constituents, the metallic portion being

tracted to the cathode, and the acid portion to the anode. This change in the tissues can be made use of medically, for fatigue products in the muscles, such as carbonic acid and sarcolactic acid, which result from excessive muscular activity, are dispersed by the cathode. This constitutes what is known as the "refreshing" action of the current, but since the anode attracts acids and repels metals, we can also drive solutions of certain metals into the tissues by this action of the anode.

This introduction of the salts of such metals as lithium and copper by the anode and of iodine and sodium by the cathode is known as ionic medication.

APPLICATION OF THE GALVANIC BATTERY. — Certain precautions must be observed before using the galvanic battery.

The skin of the patient should be carefully examined for abrasions. Wherever the skin is broken, the resistance is lowered, and the current will concentrate at such areas, causing a more or less serious burn. If possible, the area chosen for the application should be where the skin is normal. If this is impossible, the abrasions must be protected by covering them with collodion or adhesive plaster. The part should be thoroughly moistened to improve conduction. A dry or greasy skin increases the resistance. Electrodes to which the connecting wires from the battery are attached will vary with the region to be treated. They come in many sizes and shapes, but can be improvised out of copper wire mesh to which are soldered the binding screws. They are covered with felt, cotton wool, or lint, the essentials being that they should be clean, soft, smooth, and absorbent, and at least one fourth of an inch thick. Great care should be taken to have them applied to the body uniformly flat and free from creases. Burns occur at a crease because here the pressure is greater than elsewhere. The pad should also *extend well beyond* the metal edge of the electrode on every

side. Electrodes and pads may be kept in firm position for treatment by the pressure of a well-applied bandage, by sandbags, or other weights.

The two electrodes should not be placed close enough to touch each other, as the current would then become short-circuited instead of penetrating the tissues.

When both electrodes have been correctly applied, the current is turned on very slowly and gradually, cell after

FIG. 15. — Continuous current applied to the sciatic nerve by electrodes of copper mesh covered by felt, and held in place by sandbags across the thigh.

cell being brought into the circuit. The patient soon becomes conscious of a sharp pricking sensation and a feeling of heat. As the unpleasantness of this diminishes, the current can be increased. If the patient complains of much discomfort or burning, the current should be *slowly* decreased and the electrodes *remoistened* and adjusted.

The region of the cathode is the danger point. Watch it. Here burns are most likely to occur. Where anæsthetic areas are treated, keep a double lookout for possible burns, because the patient cannot help you; however severely he may be burnt, he will not have any complaints at the time. Burning may be caused by too small a pad, and a good rule is to allow one square inch of electrode for every milliampere of current used.

At the termination of treatment, the current should be turned off slowly and carefully. If you turn it off suddenly you will hear from the patient, and what you hear will not be complimentary. The electrodes should not be removed until the current is completely turned off. The skin must at once be carefully dried and examined for undue redness, blisters, or burns.

After using a battery, all switches should be turned off, the cords and electrodes dried, and metal parts polished and freed from all verdigris, and the pads rinsed out and kept in an antiseptic solution or dried.

METHODS. — When both anode and cathode are placed upon the affected part, and are of use in the treatment, the method is called bipolar galvanism. If only one is wanted and the other would be detrimental, the pole placed upon the affected part is called the active electrode, while the other pole or indifferent electrode is placed upon some remote part of the body and used merely to complete the circuit. This is called unipolar galvanism.

The method of application already described is *stabile* or stationary because both electrodes are fixed upon the patient and kept at rest throughout the treatment.

When the active electrode, usually in the form of a roller disk or sponge, is moved up and down or on and off the part treated, it is called labile or movable; and the action becomes stronger or weaker with its approach to, or recession from, *the part under treatment.*

EFFECT OF CONSTANT CURRENT. — The constant current applied to the whole body by means of a general bath has a profound effect upon metabolism. For painful local conditions, the anode is used for neuritis in its various forms, neuralgia, and inflammation. The cathode is used to stimulate the circulation in such conditions as frost-bite or trench foot, old scars, Volkman's ischæmic contraction, and other conditions requiring active hyperæmia. This may be applied in a local bath; or where this is unavailable, the labile method may be substituted, the body being treated area by area.

IONIC MEDICATION. — The salicylates of soda are recognized as being of use for rheumatic affections, lithium for gout, and copper and zinc as antiseptics, while chlorine seems to possess the additional virtue of softening recently formed inflammatory tissue. Instead of taking these drugs by the mouth they can be driven into the body by means of the galvanic current.

These salts when dissolved in water will split up into atoms called "ions" or "wanderers" or travelers, and the process is called ionization. In this way salts of iodine, sodium, chlorine, and potassium are driven in by the cathode, which repels alkalis, while the salts of lithium, zinc, copper, and magnesium are driven in by the anode, which repels metals. A one per cent or two per cent solution of the required drug is made, and the padding which covers the active electrode is dipped into it. The amount that will be driven in depends on the strength of current and the length of time it runs, the usual treatment lasting about twenty minutes. Heat your solution. It gives comfort to the patient, and it forms a better conductor for the current. These drugs are put up in the form of soloids especially prepared for this purpose, but it is quite as convenient to have them in stock solutions of about twenty per cent, which you can dilute to the required one per cent, as required. The drugs you will need are: salicylate of sodium for chronic arthritis

fibrositis, myositis, and for certain forms of bursitis, r
matism, neuritis in its various forms, especially lum
and sciatica, and for the chronic pain so often left afte
juries to joints and limbs; iodine in the form of potas
iodide, as an antiseptic; chlorine in the form of so

FIG. 16. — Application of sodium chloride solution by the cathode in an arm bath — for painful scars.

chloride or common salt for the treatment of irritable
tracting scars — all these introduced by the cathode. I
in the form of sulphate or chloride, and copper sulp
are valuable antiseptics, for suppurating sinuses, chr
ulcers, and other slow infective conditions. They are
troduced by the anode through electrodes of zinc and co
respectively.

CHAPTER III

MEDICAL ELECTRICITY

FARADISM

INDUCTION. — The second form of electricity used in medicine is produced by induction.

If you introduce a magnet into a coil of wire forming a closed circuit, an electric current is produced running in one direction. Withdraw it, and its direction is reversed. Keep it still, and no current will flow. If the coil is made to move in relation to a stationary magnet, alternating currents are also produced. This briefly is the principle upon which the dynamo works. Wind a coil of wire around a bar of soft iron and pass a current along the wire; the iron bar becomes magnetized. So long as the current runs, it is an electro-magnet. If a closed coil of wire carrying a current be brought into the neighborhood of another coil, electric currents are produced in this second coil whenever the current is made or broken. This *induced* current in the secondary coil passes in the same direction as the *inducing* current when the circuit is broken, and in the opposite direction when the current is made. Thus we obtain the *alternating current.* Its voltage can be made high by having a larger number of turns of wire in the secondary coil, so that a low-voltage inducing current can produce an alternating current of high voltage in the secondary coil. Keep these facts in mind and the mechanism of the faradic battery will be easily understood. Its *essential parts* are: (1) a source from which a continu-

current can be obtained; (2) a stationary coil of wire wound on a wooden bobbin, "the primary coil"; (3) a device in the circuit of the primary coil for making and breaking this current, "vibrating armature"; (4) a second coil of wire unconnected with the first, also mounted on a hollow wooden bobbin, "the secondary coil," in which induced alternating

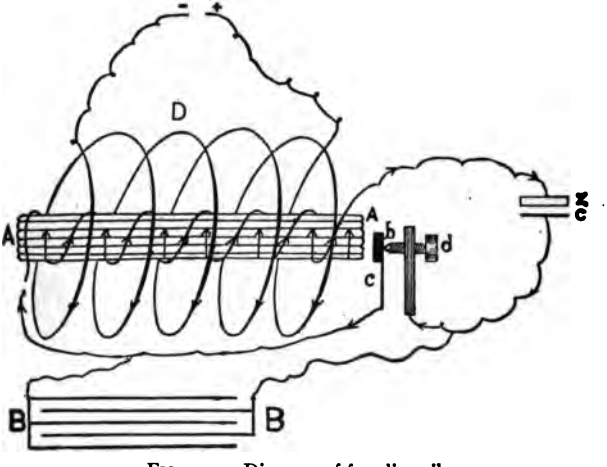

FIG. 17. — Diagram of faradic coil.

A. Core and primary coil. *B*. Condenser. *D*. Secondary coil and terminals + −. *c*, *b*, *d*, Armature.

currents are produced; (5) an iron core in the center of the wooden bobbin which becomes magnetized by the currents passing in the coils, (6) binding screws to which electrodes can be attached to convey the current from the primary or the secondary coil to the patient.

When a current source is connected with the binding *screws, from an outside,* a circuit is completed as in the fol- *lowing diagram:*

(1) Through binding screw, *A*.
(2) Up the metal support, *B*.
(3) Along the limb of the hammer to the contact screw, *C*.
(4) From the contact screw to the primary coil, *D*.
(5) From primary coil to electromagnet, *E*.
(6) From electromagnet to binding screw, *F*.
(7) Thence back to cell.

At the moment that the current passes from the cell through the circuit, the iron rod *E* is converted into an electromagnet strong enough to attract the head of the hammer, thus drawing down the limb of the hammer out of touch with the contact screw. When the hammer leaves the contact screw, the following sequence of events takes place:

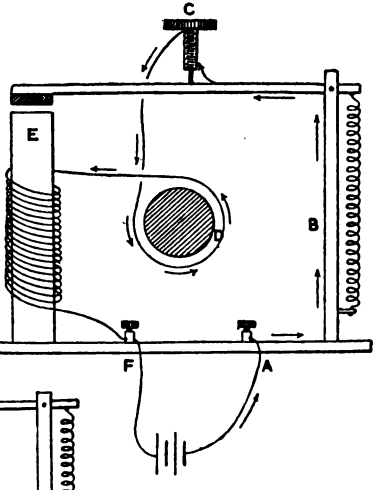

FIG. 18. — Current open.

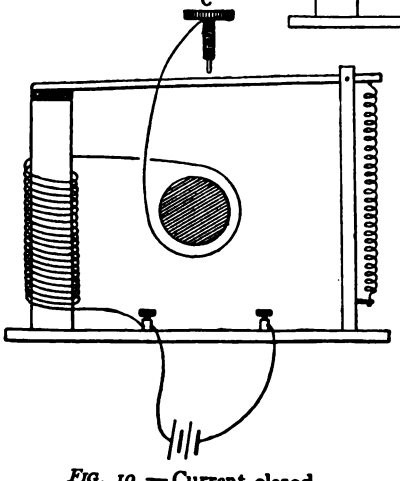

FIG. 19. — Current closed.

(1) The circuit is broken at the contact screw.
(2) The current ceases to flow.
(3) The iron rod ceases to be a magnet.
(4) The hammer is released, and is caused to fly back to the contact screw by the tension of its wire spring.
(5) The circuit is remade at the contact screw.
(6) The current again flows through the circuit.
(7) The iron rod is remagnetized, attracting the hammer to it and again breaking the circuit.
(8) This sequence of events occurs again and again with great rapidity: thus the constant current from the cell is automatically converted into the rapidly interrupted current of the primary winding.

The rate at which these interruptions can be produced can be varied by adjustments of the interrupter. The arrangement of the two coils and of the central core varies with different instruments, but the principle is the same. The primary coil gives an interrupted current flow in one direction which resembles the interrupted galvanic current except that it is jerky and uneven, the make and break being of different strengths, and it is painful to the patient. The current in the secondary coil alternates rapidly but the alternatives are uneven. It is always to be remembered that the currents in the secondary coil are induced and have no direct continuity with those of the primary.

One of the most useful forms of faradic battery has the same number of layers of wire in the secondary, which is the current used, as those in the primary, the secondary current being no stronger than the primary in consequence, with an interrupter arranged to give perfect regularity of rhythm, and a condenser to steady the current. In it a thick core of soft iron is made to slide easily in the primary bobbin. The sliding of the iron core in and out regulates the current by decreasing the amount of the current which is in use as the core is withdrawn and increasing it as it is shoved in. The

produces a painless muscular contraction which is capable of perfect control, the operator being enabled to produce anything from a faint tremor to full contraction of the muscle.

EFFECTS. — The effect of the faradic current upon muscular tissue is very much like that of the normal nerve impulse to the healthy muscle. The current is readily conducted along the nerve and enters the muscle through it. It is rapidly distributed to every part of the muscle and throws it into a series of contractions synchronous with the make

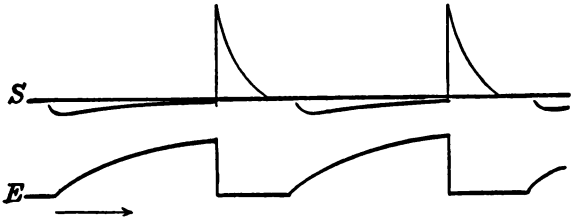

FIG. 20. — Curves of primary (*E*), and secondary (*S*) faradic current.

and break of the current. If the interruptions are rapid enough and the current strong enough, the muscle fibers are thrown into tetanus, which causes rapid exhaustion. At each normal contraction of a muscle the blood is squeezed out and new blood flows in during relaxation, but in tetanus the muscle strangles itself. The value of faradism from a medical standpoint lies in its power to act as a substitute to normal nerve impulses when they are not fully conveyed to the muscle.

When nerves, through disease and degeneration, have lost all power of conducting their normal impulses, the muscles remain passive under this form of electric stimulation, but if *we turn on the* galvanic current to the same muscle, it will *sluggishly* respond to the chemical stimulation of its substance. This difference in the action of the two currents

the same muscle enables us to secure the "reaction of degeneration."

USE OF THE FARADIC BATTERY. — Place the indifferent electrode, a metal plate four or five inches square covered with lint, over the nerve trunk or plexus and the active electrode over the motor point, after wetting them both in soapy water to remove grease. The active electrode should be a metal disk about two inches in diameter covered with lint. The electrode is grasped, together with the muscle, between the thumb and forefinger of the left hand, and with the other hand gradually insert the core into the coil. The amount of contraction is estimated by the feel of the muscle under the left hand. The core is inserted and withdrawn rhythmically at about one-second intervals, or the mechanical metronome is used. Fatigue, felt by weak, irregular contractions, is a signal to stop. The motor points of all the muscles can be found by consulting any good chart. Great care must be taken not to produce exhaustion, as muscles recover slowly, and may be badly damaged by overstimulation.[1]

This surging faradism is also used in applying strong currents over large areas, the current being slowly and rhythmically increased and decreased by the metronome or rheostat. In this way a good substitute for exercise can be obtained. Bergonie has used it for exercising the abdominal muscles in obesity, and Kellogg for cases where the heart will not permit more active exercise.

The general effect of faradism is to stimulate muscle activity, and to improve the local circulation by which the general nutrition of the patient is benefited. This stimulation is employed in many conditions from which wounded soldiers suffer. In functional neuroses, the thyroid glands, *which are so frequently* enlarged, may be reached by its *application to the sides* of the neck. Many cases of aphon

[1] *Treatment of Joint* and Muscle Injuries, by W. Rowley Bristow

are cured by its careful use over the laryngeal muscles, throwing them into spasm violent enough to make the patient cry out. In the treatment of weakened muscles the current should be strong enough to produce a brisk contraction, but not strong enough to cause pain, and the dangers of overfatigue must always be kept in mind.

COMBINATIONS OF ELECTRIC CURRENTS. — The galvanic and faradic may be combined. If a part of a muscle or

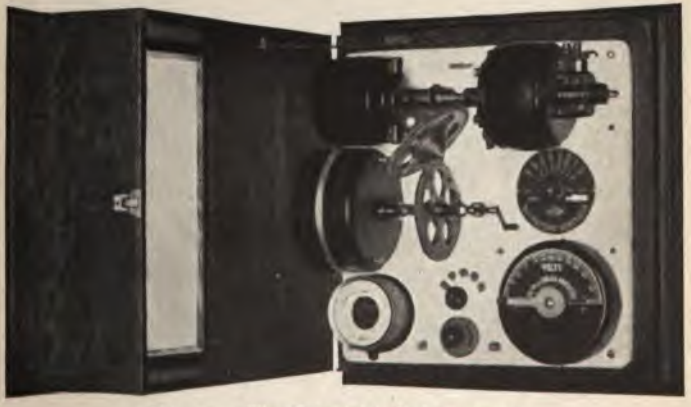

FIG. 21. — The McIntosh polysine generator.

group were responsive to galvanic stimulation only, it would be neglected if the faradic stimulation only were used.

They are combined on most switchboards and on all of the combination machines known as pantostats, multostats, compostats, or universal machines. These machines in every case consist of a small motor which is used to operate a dynamo which generates a current. This current has no *direct connection* with the source of supply to the dynamo *It is of low voltage* and can be used for treatments with p

Fig. 22. — Medical switchboard.

fect safety. If the current from the main were used, it would be too high in voltage and would also be dangerous if suddenly interrupted while the galvanic current was in operation, as it will be remembered that a twitch is produced every time the current is made or broken. This low-voltage current is led off to various terminals labeled galvanic, faradic, and sinusoidal, with their combinations.

SWITCHBOARD. — The medical switchboard is supplied from a main current or accumulator, and is then distributed

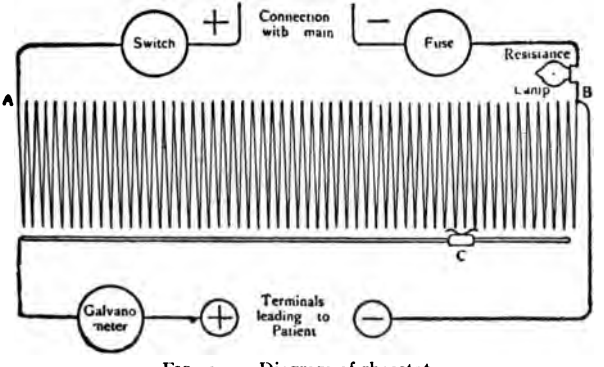

FIG. 23. — Diagram of rheostat.

to the terminals through certain safety devices which prevent sudden variations in strength. These consist of the fuse, or blow-out, to prevent the current from becoming too strong, and the rheostat for regulating its strength. There are also the reversing switch for changing direction and the galvanometer for measurement.

Both forms of electricity are in constant use for injuries in which the *nerves* are completely or partly destroyed, and the *stiff, contracted,* or weak hand may make its first moveme *towards recovery* through their use. For paralyses, trem

areas of anæsthesia, and disturbances of the special senses, the more stimulating forms would be effective. The disorderly heart can be helped back to reason by faradism and the sinusoidal current, and ionic medication has proved its value for rheumatism in its many forms and in the after-effects of wounds resulting in sinuses or in the formation of scar tissue and contractures, as has already been insisted upon.

CONDENSER IMPULSES. — The condenser may be considered as a means of storing a definite quantity of electricity. It consists of two insulated conductors each presenting a large surface to the other with a small distance between them. When one conductor is connected to earth, a small electromotive force is able to charge the other with a much larger quantity of electricity than if it stood alone. The Leyden jar is an example. (See also Fig. 17, *B*.) The discharge of a condenser through a coil takes place by a series of oscillations like that of a flexible bent rod when released.

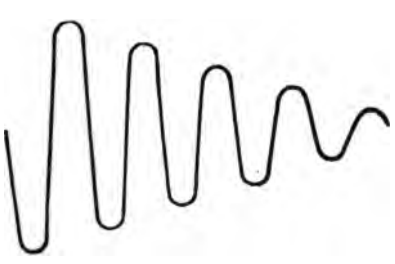

FIG. 24. — Oscillatory discharge of Leyden jar.

HIGH FREQUENCY. — An induced current having a frequency of millions to the second, at a high voltage and low amperage, can thus be obtained by introducing into the circuit a Leyden jar, a spark gap, and a solenoid (wire spiral). This form of current is applied direct to the patient through vacuum electrodes, or metal plates grasped by him or placed against his skin. The rapidity of the oscillations is such that a large *volume of the* current (800 milliamperes) produces but slight *physiological or chemical* effect, and muscular twitches or *tinging sensations* are not perceived from this current, how-

ever strong, which changes its direction at a rate of a million to the second. Its strength is controlled by a rheostat. It is even possible to light a high-powered incandescent lamp through the body, without any shock or other feeling, except one of heat.

DIATHERMY. — The quality for which it is most used in medical treatment is the production of heat, caused by the resistance the tissues offer to its passage. The patient grasping the electrode

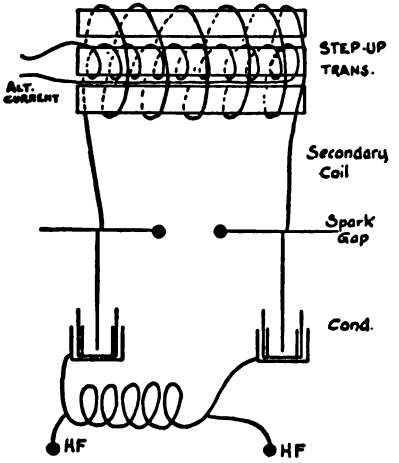

FIG. 25. — High frequency apparatus.

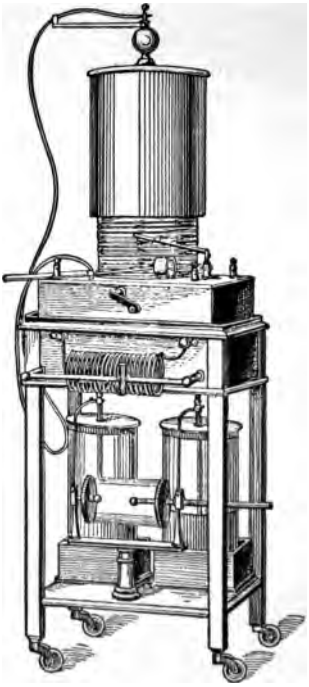

FIG. 26. — Composite high frequency apparatus.

feels an *immediate* sensation of warmth, and it can be demonstrated that its penetration is great, and affects the *deep-lying tissues*. It is of value for the production

hyperæmia, and makes an excellent preparation for massage, by flushing a joint or area of scar tissue with blood just as is done by a hot bath.

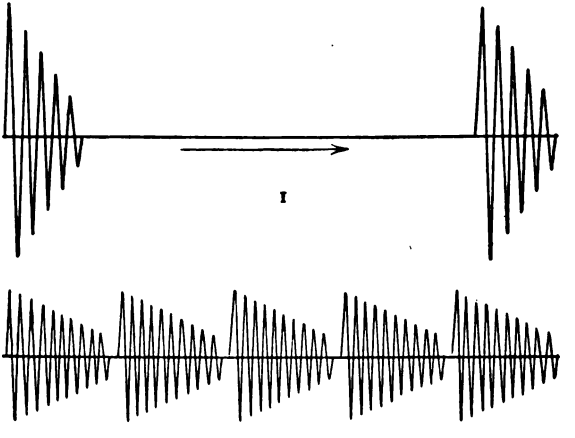

FIG. 27. — High frequency (1) and diathermy (2) oscillatory discharges compared. Lewis Jones.

STATIC ELECTRICITY. — The third and oldest method of producing the electric current is by friction, and in the earlier machines this was done by revolving a glass plate between stationary brushes. The brushes were charged positively and negatively so long as the plate revolved, producing a continuous current of high voltage and small volume. The next step was to start the machine by friction and continue its action by "influence" or induction. In the Holtz machine, one plate of glass revolves in close proximity to another *slightly larger one.* The machine first is charged from an *outside source before* starting, but the current continues, *nce it is started.* The Wimshurst machine is self-starting.

It consists of from two to twelve circular glass disks mounted in pairs and made to rotate in opposite directions at a distance apart of not more than a fraction of an inch. It is really a friction machine as well as one using induction or "influence." Owing to the high tension of the current, insulation is important, and the patient is usually placed upon a platform with glass legs. The electrodes used are a point, a ball, a roller, and a brush. As it gives a continuous current, it has polarity, and this must be determined by the character of the spark. The treatments

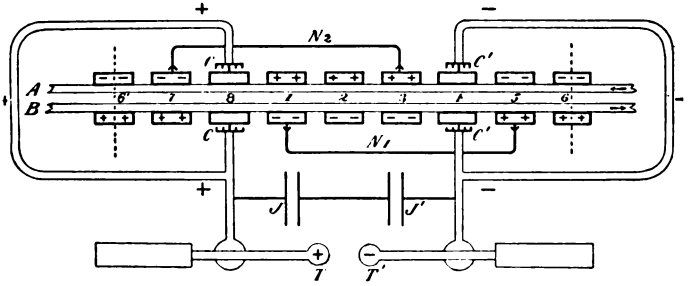

FIG. 28. — Diagram of static machine.
J, J, Leyden jars. *C, C*, Collecting brushes. *A, B*, Glass plates. *T, T*, Terminals.

are *simple charging*, which increases blood pressure and pulse rate, but acts as a sedative in sleeplessness, when the anode is used; *the Morton wave current*, a static wave, in which the patient is alternately charged and discharged, producing contractions, a tonic treatment; *the brush discharge, or breeze*, which gives a cool and agreeable sensation like a douche of hot sand, leaving a warm glow after-effect — it is useful in soothing the pain of neuralgia, neuritis, and nervous irritability of "shell shock" *single sparks*, given by the ball — the effect is like a blo *and is followed* by a reflex muscular contraction, stimu

ing in its effect, and producing relaxation of spasm. *Electric friction* by the roller gives a shower of stinging sparks and so resembles the spark. It gives intense cutaneous stimulation, but no penetration. It is followed by redness of the skin.

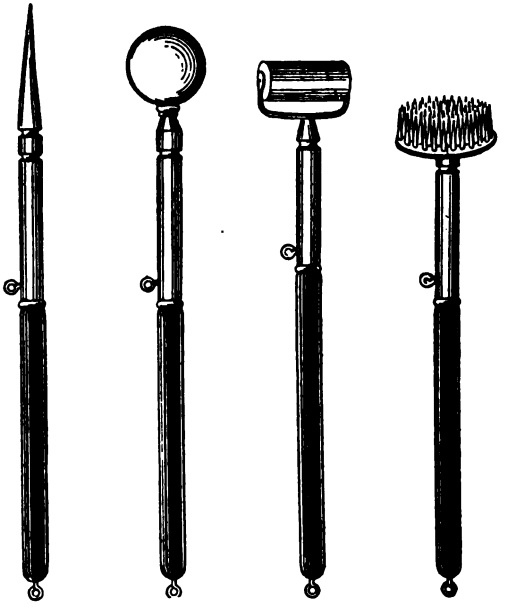

FIG. 29. — Electrodes for static machine.

The care of the machine and the technique of the various forms of treatment are too complicated for a handbook of this length. The reader is referred to standard works for further particulars. They are not taken up here, because the machines are not in general use, except in special hospitals, and by specialists. They do not form part of a standard equipment for convalescent hospitals.

CHAPTER IV

RADIANT LIGHT AND HEAT

THE sun's rays have always been used as a curative agent. If they be passed through a prism to divide them into the colors of the spectrum, they will be found to extend above and below the range of visibility. The infra-red rays, with a low frequency of vibration, give out heat and penetrate the tissues of the body deeply. The ultra-violet, with a high frequency of vibration, are mainly instrumental in producing the cutaneous irritation known as sunburn. All artificial sources of light contain these heat, light, and ultra-violet or actinic rays in varying proportions. The arc light is rich in actinic rays; the incandescent is rich in heat rays. By passing through a screen of red glass the actinic rays can be cut out and by using a violet screen the effect of the heat rays can be diminished, a result that can be obtained equally well by a douche of cold air on the part.

The electric arc light most nearly approaches sunlight and can produce an erythema just like sunburn, and when repeated daily a definite pigmentation of the skin like tanning. It has a marked bactericidal action which makes it especially useful for many skin diseases. The light is applied by the solar therapeutic lamp, mounted upon a portable stand (see figure), and adjustable for position, distance, and strength of current. To apply it, the patient is seated and *the lamp adjusted* to the part to be treated. The current *is thrown on* and regulated by a rheostat starting at

minimum intensity. The treatment should not last more than one or two minutes at first and will be followed by

FIG. 30. — Arc light with fan. — Kellogg.

reddening of the skin. The length of time for the treatment *an be increased with* tolerance just like exposure to the sun

the effect is counterirritant, and is useful for referred pains, neuralgia, rheumatic pains, and skin infections. The treatment of joints requires deep penetration and for this purpose a light with more heat and fewer actinic rays is to be preferred; but it must always be borne in mind that all three are present in most of the lights that are in general use.

Radiant heat causes a dilation of the surface capillaries drawing the blood out from the deeper parts. This is succeeded by a contraction of the superficial and dilation of the deeper vessels, so that the flow of blood to the part is stimulated just as in diathermy.

The masseuse who first heats the limb is thus able to work on a part already flushed with blood instead of pumping it in by massage, and the beneficial effect is increased directly with the increased volume with which she starts, for the exchange in the circulation will be correspondingly hastened. The athletic trainer who would send a runner or jumper out for a contest without first warming up the muscles would run the risk of having him pull a tendon or rupture a muscle, and preliminary massage to heighten the circulation in the muscular tissue is the best preventive of such an accident, especially if it is continued by putting on a warm woolen covering to retain the heat.

The heating of a part in all cases where the circulation is lowered is essential before other treatment is undertaken. Scar tissue has poor circulation at best, and frequently the toothache-like pain in it is relieved by raising the temperature and improving the local circulation alone. In all cases, weakened and impaired muscles should first be flushed by blood before having the massage and active movements that complete their treatment. Certain superficial scars become sodden and tender if wet heat is applied, so that dry radiant heat is especially indicated for them.

The *most convenient* form for giving a local treatment *consists of a lamp* of about 60 c.p., contained in a metal c

lined with a metallic reflecting surface. This is moved back and forth or in circles a few inches from the surface,

FIG. 31. — Head lamps. — Kellogg.

until the temperature of the part is sufficiently raised as *shown by reddening* of the surface. Care must be taken to

avoid scorching the skin, where the part is anæsthetic. The patient will see to that if the sensation is normal, and the treatment should never be carried to the point of extreme discomfort, nor should it be continued more than three or or four minutes. Toleration is increased by moving the lamp about. The first dilation of the surface capillaries is what is wanted.

The second form is called the local electric light bath. This is composed of six or twelve 16 c.p. lights contained in a reflector, so placed in relation to the part that a constant temperature can be maintained. It is important that there shall be an even distribution of light and heat over the entire area, that a wide range of control be allowed from a low graduated heat continued for fifteen to twenty minutes to the most intense that can be borne. It should be light and portable and, in every case, the operator should be able to observe and regulate the temperature by means of a thermometer. The limit of temperature in these baths is about 180°, although, if ventilation is allowed and the air kept dry, the temperature can go up as high as 300°. This form is used when we want to get more than a surface effect in myalgia and rheumatic joints. In all cases, the heat should be put on gradually and reduced gradually, and the treatment should not last more than twenty minutes.

FIG. 32. — Local bath adjustable and with thermometer. — Burdick.

The third form is a full electric light bath. Apparatus is constructed so that this bath may be given with the patient in bed (see illustration). By combining two of these appliances, we can make a cabinet in which the patient may be seated. This cabinet contains forty to fifty 16 c.p. incandescent lights. A thermometer enables the operator

FIG. 33. — Full electric light bath for a bed case. — Burdick.

to regulate the temperature, and the whole body is placed within the cabinet except the head. The temperature is raised to about 100° before the patient enters and the current gradually increased until 160° or 180° is reached, cold water compresses are applied to the head, and the patient should drink water during the treatment to promote sweating. If fainting threatens, the treatment must be stopped; and if, at any time, the patient feels faint, the pulse should be

counted and the treatment stopped if it rises above 120. This bath should last from thirty to forty minutes. The patient then leaves the cabinet, takes a warm sponge bath, and rests between blankets for at least half an hour. They should not be given more than twice or three times a week. The effects of these baths are, first, redness of the skin; second, a profuse perspiration; third, acceleration of the pulse, which should remain strong and regular throughout the treatment; fourth, rise of temperature during the treatment, which falls to normal after; fifth, increase of elimination, both by the lungs and kidneys. They should not be followed by a feeling of lassitude. They are of great value in all forms of intoxications, alcoholic, rheumatic, gouty, and nephritic, and relieve congestion of abdominal organs, like the liver, spleen, and kidneys.

FIG. 34. — Cabinet bath made by combining two appliances as shown in Figure 33. — Burdick.

STEAM COMPRESSES. — Dry heat without light can be applied locally by Kellogg's apparatus, the electrotherm*phore, hot water* bags, or hot salt or sand; and the el*tric light can* be applied to give moist heat as well, thr

the steam compress, which consists of a container with air-tight covering, in which is placed a linen pad wrung out of cold water. This is placed on the part to be treated, and the local heat bath is placed over it until the compress is brought

FIG. 35. — Kellogg's thermophore.

to the desired temperature, where it can be kept indefinitely without changing. The advantage of this over the old method of wringing cloths out of hot water will be at once apparent.

CHAPTER V

HYDROTHERAPY

HYDROTHERAPY has the additional resource of cold as well as heat, and like radiant heat it can be applied to the whole body or to a single part. Most wounded men are quite sound except for the injury to a leg or arm and require treatment for that only.

In these cases its great field is in preparing the part for treatment by massage, stretching, and reëducation. The cases that derive most benefit are healed wounds with great areas of contracted scar tissue — painful stumps and weak and stiffened joints in which the circulation is far below normal. After treatment for twenty minutes by whirling water at 110 to 115°, the cold, blue, painful limb becomes red and warm, and the apprehension of the patient to any form of manipulation disappears under the feeling of well-being and comfort that results. Spasm disappears, and the part becomes soft and relaxed. Masseurs unite in declaring that muscles and joints are then more easily manipulated, a judgment in which the patients themselves heartily concur. Slight adhesions can frequently be broken down without pain and function quickly restored. Irritable bruised nerves, however, may be made more irritable by this method, and the temperature should then be not more than 100, no *should it be* followed by any manipulation. The warm *of the water* should here act as a poultice to soothe the

A sort of gymnastics for the circulation can be given by dipping a limb alternately in hot water which dilates, and cold which contracts, the capillaries. The vessel walls are thus exercised and their tone trained to respond to the normal stimuli of heat and cold.

For general treatment, water is also used, hot or cold. The man who is tired out finds himself restored to vigor by getting into a hot bath. The blood is drawn out to the surface from the brain and abdomen and the whole circulation redistributed, but here again it must not be continued past the first flush, otherwise there is a rapidly increasing debility.

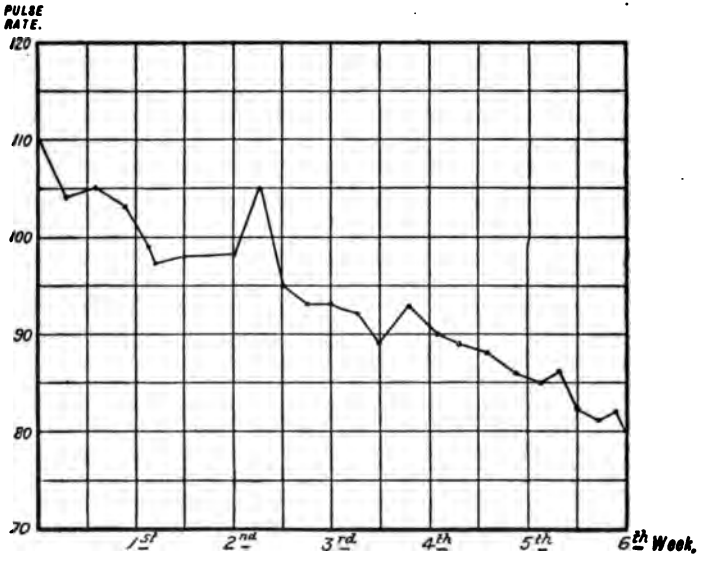

FIG. 36. — *Average pulse* rates of ten cases of disordered action of the heart *during six weeks' treatment* by the pool bath at Heaton Park. — Dr. Frank Radcliffe.

One evening after a long drive I plunged into a thermal mountain spring at about 100° and swam in it for ten minutes, sometimes with my head under water. No cold shower was taken to follow, and the result was a headache, suffused eyes, a sleepless night, and an assiduous use of the pocket handkerchief for the next twenty-four hours. This illustrated the results of neglecting to secure the necessary reaction.

As soon as the flushing of the surface is obtained the patient should be removed and a cold shower taken to get a good reaction, or the patient put to bed with the room at an even temperature till the vessels regain their equilibrium.

For conditions following shell shock, irritable heart, hallucinations, fearful dreams, and neurasthenia, the general poultice of a bath at 94°, kept up for an hour or more is hard to beat. This has long been recognized in the treatment of mania in the insane, and the conditions are sufficiently close to form an analogy.

Water is a good conductor of electricity, so that this agent may be applied through a local or general bath, as already described in Chapter II.

The hydrotherapeutic equipment, necessary for the treatment of disabled men, consists of a douche and shower, immersion tubs, or a pool for water, kept at a constant temperature, local baths for the treatment of arms and legs, and electric baths for both local and general application.

THE DOUCHE. — The douche should have a powerful jet, the stimulant effect of the water being increased by its force which may go up to thirty pounds.

A treatment should always begin by warm water (90°), rising to hot (115°) and ending with cold (60)°. It should not last more than one or two minutes, and, where the stimulant effect must be great, the Scottish *douche should* be applied. In this two jets, one *100 degrees* and the other at 60 degrees, are applied a

FIG. 37. — The douche, showing wall control and shower needle baths in action. The table control is much more expensive and elaborate.

nately by a lateral sweep of the nozzle up and down the spine. This plan is also used in the local contrast baths of Robert Jones for exercising the circulation of an arm or leg. The shower is a gentler form of this treatment in which the

massage of the water jet is absent, but the same rules apply to it as to the douche.

IMMERSION BATHS. — Immersion baths are given at three temperatures, below, at, and above the skin temperature. The bath at 94 degrees, skin temperature, is soothing in character, a good sedative. Its greatest use is in decreasing

FIG. 38. — The pool bath at Heaton Park. Capacity twelve men. Temperature of the water 94°.

nervous irritability, in whatever form it may be, and in soothing a disordered heart. After one hour's immersion the patient should be wrapped up and allowed to rest for another hour. The relief from the constant and insidious irritation of clothing and movement, and the support of a medium of about the same specific gravity as the body, doubtless accounts for much of the benefit.

The hot bath (98 to 110 degrees) dilates the peripher
vessels and increases the frequency of the pulse. Its m

is founded on its stimulant effect on the circulation. The blood is drawn out to the surface, which becomes red and warm. The effect is somewhat the same as the cabinet bath, without the perspiration, and it is of special use in the treatment of fatigue and also in chronic conditions in which the general circulation is sluggish. The immersion should be very brief, not more than five or ten minutes, and should be followed by a cold shower to restore the tone of the dilated vessels, and the patient should be wrapped up and put to bed for an hour.

LOCAL BATHS. — The whirlpool baths have proved their value in the after treatment of wounds, during the present

FIG. 39. — Two arm and one leg whirlpool baths. Heaton Park.

war, and are widely used. The arm or leg is thrust into a vessel containing water at a temperature varying from 105 up to 115 degrees. This water is circulated by means of jets set at an angle or by a propeller. Air is also introduced, so that the limb is immersed in a swirling, bubbling current. In this way the part is flushed with blood, and the full effect

of heat is obtained in a way that is impossible if the water is still. The air bubbles increase the stimulant effect on the skin. They are peculiarly adapted to the treatment of painful stumps, painful scar tissue, partial paralysis, injuries to nerves, and, in fact, to any condition which lowers the circulation and nutrition of the part. The period of immersion is about twenty minutes, and with increased toleration, it may be possible to raise the temperature as high as 120 degrees. Great caution must be used to prevent scalding, especially if any area of anæsthesia is present. It makes the best preparation for massage and manipulation in cases where the limb is cold, blue, and painful. Movements and manipulations can then be performed which would not be tolerated by the patient without this preparation.

CONTRAST BATHS. — The contrast bath is a form of gymnastics for the circulation, which is like the Scottish douche in its effect. It consists of two oblong baths, placed side by side, one supplied with water at a temperature of 110 degrees, the other supplied with water at 60 degrees. The patient dips the hand or foot alternately in these baths, leaving it in for about two minutes. They are applied to all conditions in which the local circulation requires stimulation.

ELECTRIC BATHS. — The use of a glass or porcelain vessel made to contain an arm or a leg permits the use of electricity and ionic medication through the medium of water. The vessel must not be metallic or a conductor. Water at, or slightly above, the skin temperature is used, and an electrode of copper or carbon is placed in the water at one end and the indifferent electrode applied to some part of the body by a large pad. The polarity is determined unless the sinusoidal current is used, and the current turned on till a tingling sensation is felt. It is afterwards increased with added toleration. Twitching of the muscles can be obtained rhythmical interruptions of the current, and the laws gov

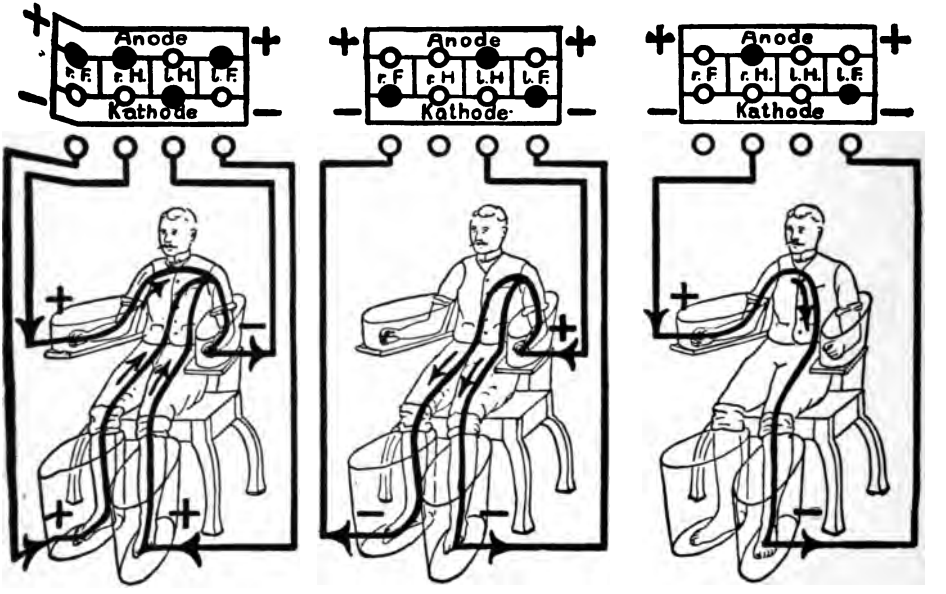

FIG. 40. — The variations of current direction possible in the Schnee four-celled baths.

ing ionization already described would apply (Chapter II). The entire current passes through the limb from or to the indifferent pole, and in this the unipolar local bath differs from the general electric bath. Various combinations are made of arm and leg, right and left, by the Schnee baths, which come complete with switchboard and commutator.

In the immersion bath, which must be carefully insulated, two large copper electrodes are inserted, one at either end. They are protected so that they cannot be touched by the patient. The bath is filled with water at 100 degrees, the patient immersed, and the current turned on slowly. The patient should be conscious of a pleasant tingling sensation. The period of immersion should begin at 15 minutes and go up to 30. The current is slowly turned off before the patient leaves the water to take a half hour's rest, well wrapped up. It is probable that not more than one tenth of the current passes through the patient; the rest goes through the water.

The bath should not be of metal. If the current is from the main, it must be carefully insulated from the waste pipe. Taps and switches must be out of the patient's reach, and additional water added from a jug. In fact, owing to the necessary precautions, this bath is not recommended except under most skilled supervision in special hospitals.

It is used for neurasthenia and debility, and the current employed is the sinusoidal or galvanic.

MEDICATED BATHS. — In most of the spas, medicated baths can be obtained. These are taken up in the full description of each spa. They are saline, sulphur, or iron, and can be prepared artificially.

A shower or douche is frequently given combined with massage and manipulation carried along under water, the patient reclining in a hollow table bath. Its value is not great enough to make it worth while to install the expensive *and complicated* apparatus necessary.

CHAPTER VI

MASSAGE AND PASSIVE MOVEMENT

MASSAGE in its many forms is used to dissipate effusions after sprains, to soften and stretch contracted scars or adhesions, to prevent atrophy and contractures following nerve injuries and fractures, to stimulate the circulation after frostbite, and to improve general nutrition in local and general rheumatism. It is of great value as a preliminary to operation to loosen scars and make operation easier, and to excite inflammatory action about a sequestrum and help to expel it, or to diagnose any lurking infection in an old wound.

Aimless rubbing is as useless as waving a palm-leaf fan, if the operator be weak and timid, but it has the additional possibilities of doing much harm if the operator, besides being ignorant, is rough and strong. Sometimes massage is of value when passive movement is contraindicated, and of the manipulations of massage themselves, tapotement may be effective when effleurage would be useless, as will appear.

Effleurage is essentially a surface manipulation. It forms the beginning of treatment in all painful conditions like sprains, fractures, or after breaking down adhesions. It is a preparation for more active manipulations. The hand is passed lightly over the skin, like stroking a cat, usually from the periphery to the center. It is performed by the palm of the hand, the thumb, or the finger tips. Both hands are used for large fleshy parts like the buttock, thigh, chest, back, or neck; the thumb or finger tips are employed around

bony parts like the hand, ankles, wrist, forehead, and scalp, and about adherent scars; the fingers adapting themselves to the part worked upon. If properly done, it should act as a sedative to pain; and when the fears of the patient have been stilled, friction may be made vigorous enough to act upon

FIG. 41. — Effleurage of the arm.

the deeper structures and wake up the sluggish circulation in and about the seat of trouble.

In petrissage or kneading, the skin moves with the hand like a glove. It is done with the thumb opposed to the hand, the fingers opposed to the palm, or the two hands opposed to one another. The muscles are rolled under the hand and skin, and intermittently pressed against the underlying bon *It is slow and deep*, usually following the course of the ven *circulation.* This manipulation should be firm, but no

painful, — persistent pain following treatment means either a clumsy operator or a condition that should not be massaged. It is most useful for stretching adherent scars, for removing the products of fatigue or effusions, and for improving the blood supply. It is the main manipulation used in general

FIG. 42. — Kneading the calf muscles.

treatment for rheumatism, fibrositis, or lowered circulation from any cause.

Tapotement or striking is a surface and also a deep manipulation. It consists of slapping with the open hand, hacking with the ulnar border of the hand, using the tips of the fingers like a flail, or beating with the flat of the clenched knuckles. The blows should be sharp and quick, short and snappy, done from a loose wrist, but not heavy enough to bruise. The main action is stimulation of the superficial nerves. The vessels dilate and the part becomes reddened. If repeated long enough and strongly enough, sensation is dulled.

Vibration is a rapid form of tapotement, in which the rate of the strokes runs from 500 to 5000 to the minute, and is best performed by a machine for the purpose, with the various forms of applicators for the different regions. Vibration is followed by a feeling of numbness, then tingling, and then warmth, so that its general effect is stimulation.

FIG. 43. — Hacking with the ulnar border of the hands.

Always plan beforehand the choice and sequence of these procedures in a treatment, and do not continue one manipulation more than four or five minutes over one region. It should then be interrupted and replaced by another procedure, but a definite sequence thought out and maintained. Limit your conversation with the patient to the giving of directions and don't let the treatment degenerate into a social visit accompanied by the aimless rubbing, pulling, and *twisting of a limb*, which too often goes by the name *massage*.

The surface to be treated should be scrupulously clean, and should not be greased or oiled, except occasionally about a tough and irritable scar. The part may be dusted with

FIG. 44. — The vibrator in use.

talcum powder, and a very hairy surface may even be protected from irritation by manipulation through a silk or cotton undergarment.

A stiffened joint or painful scar should be prepared for massage by heat in the form of baths of running water at about 110 degrees for thirty minutes, or by exposure to radiant heat until it is thoroughly reddened. Where these are not available, it may be packed in hot sand or salt, — anything that will flush the part with blood greatly assists

in making possible massage and manipulation that would otherwise be too painful.

In sprains, or after breaking down adhesions, which is the same thing, massage should be given at once, beginning with effleurage and continued by kneading, alternating these two procedures until the whole region has been covered, and supporting the ankle or elbow between treatments by a bandage over cotton wool to exert elastic pressure. In certain fractures the splint may be removed for treatment as early as the third day and effleurage given above and below the seat of fracture. The technique is too complicated to go into here, but is fully described in Mennell's book on massage.[1] Stumps of limbs remaining after amputation should be prepared by heat, given effleurage kneading and vibration to improve nutrition and promote absorption of scar tissue; and where necessary, contractures should be stretched, followed by movement and exercise for reëducation.

Red in a painful scar is the color signal of danger for the masseur who intends to stretch it. It means that there is a network of vascular loops whose thin walls are easily torn, that will bleed and form new scar tissue if roughly handled, leaving that man's last condition worse than his first. Treatment must begin, in such cases, with effleurage, light circular friction, and kneading of the neighboring tissue.

Scars may not show their true character on the surface. An innocent looking surface scar will often show a slight dimple which is deepened by any voluntary movement of the muscles, and dissection would show that it has spread out its tentacles deep into the surrounding tissue, strangling in its grasp nerves and vessels, and adhering tenaciously to bone and muscle far from its apparent place. Persistent pain following treatment always means too much force. Some patients *wince* on the slightest touch, but this false pain must *be distinguished* from real and persistent variety. Slow

[1] *Massage, its Principles and Practice.* J. B. Mennell.

and gradually increase the pressure or tension, and at the same time distract the patient's attention. This will frequently serve to make the diagnosis clear.

Massage may be used to assist in removing a sequestrum or foreign body. A red spot appears over the site of persistent pain, the skin opens, and the dead bone is extruded more rapidly than if left to unaided Nature. After wounds by high explosives or shrapnel, it is a frequent experience to thus bring to the surface and extrude bits of belt buckle, shreds of cloth, or fragments of shell. Here the pain following treatment will be continual until the disturbing cause is discharged, but the masseur is here assisting Nature in her work of elimination. Such cases require the most careful supervision, and if inflammation becomes intense or widespread, stop until it has quieted down.

General massage is best given at an hour midway between meals, and never immediately after a meal. The séance should last from thirty to forty minutes and be followed by a rest. The limbs should be taken in sections, and the general direction of the manipulations be directed from extremity to center.

PASSIVE MOVEMENT. — Passive movement is used to stretch contracted scars, to increase the range of movement in stiffened joints, to rehearse the movements of joints whose muscles are paralyzed or weakened and thus detect or prevent contractures. It does not always accompany massage, and may be contraindicated as in some fractures or imperfectly healed wounds. It may be necessary to early them out with the limb on a splint to keep weak muscles relaxed and free from strain, — the dropped wrist or foot may have to be kept dorsi-flexed, and the arm with deltoid paralysis abducted.

All movements should be done by slow, insistent pressure; *never use quick or jerky* motions; they frighten the patient, *and he locks the joints* to resist the attack. Distract the

patient's attention from the movement that is being given, especially in functional cases. It greatly assists in getting a fuller range of movement, and suggestion, deception, encouragement, scolding, or even bullying, all have their uses in such cases. Slight adhesions can be broken down with great relief by this means, especially if the part has been well prepared by heat, but serious or firm old adhesions should be left alone or broken down by the surgeon under an anæsthetic. After such an operation, for the breaking down of adhesions, passive movement should be started the following day, and the joint moved once only through its range. This should be repeated every day, and the limb kept at rest between treatments. Don't make a pump handle of such an arm. It is like a fresh sprain, and must be given a chance to become quiet, which is impossible if it is worried incessantly. In all cases of scars and contractures in which pain persists for twelve hours after treatment, rest the joint and fix it in the best possible position, if necessary by a splint, until the pain has disappeared, then start with massage only, without movement, given after adequate preparation by heat. An old white scar can be stretched only by continuous tension, best given by the use of splints, which should be worn for weeks or even months and even then the added movement is got mostly by stretching the sound tissue that surrounds it.

Passive movement of single fingers is done best by the operator's hand, the joint being slowly extended and flexed as far as possible, and the improvement maintained by a splint worn between treatments if necessary. This is especially true of functional contractures where fixation in the correct position is essential until the patient can be taught to maintain the correct position himself.

The wrist is flexed, extended, adducted, and abducted, by *the operator's* hand passively as follows: The patient's h*should be* clenched and grasped by one hand, the other be

used to steady his forearm. The movement should be strong, firm, and slow.

Pronation and supination may be done passively by the hand of the operator, seated facing him and grasping the patient's hand, palm to palm, the patient's arm and forearm being kept at right angles, and so fixed as to prevent rotation of the shoulder. It is the old game of twisting wrists.

Flexion and extension are performed by the same grasp of the hand, and from the same position.

Rotation of the shoulder is performed by the operator as follows:

The patient sits with the arm down, the forearm flexed at a right angle. The operator, standing behind him, grasps the wrist and forearm with one hand and the shoulder with the other. The elbow is the fixed point, and the wrist is used as a lever, being brought out and in slowly without changing the angle of flexion at the elbow.

Circumduction is performed by seating the patient on a stool, the arm stretched straight out to the side, the operator standing behind with one foot on the bench, and the knee under the axilla to steady the shoulder, which is also held by one hand, whilst, with the other, he circumducts the shoulder by grasping the arm just below the elbow. Slight adhesions may be broken down by these means, not only without injury, but with great relief to the joint, but any persistent pain after treatment warns the operator of the necessity for caution.

Circumduction of the ankle is done by the hand, but full flexion is difficult or impossible when the powerful tendon Achilles is contracted, and a preliminary tenotomy is often indicated. The hold for this purpose is shown in Fig. 45.

Flat foot and claw foot (pes cavus) are often treated for *long periods* by massage and passive movement without results. *These procedures* can have but a minor place in the *treatment of such* conditions, and they should be referred

for surgical or orthopedic treatment by operation, support, and reëducation.

Flexion and extension at the knee may be done by the hand, the patient being seated with the leg over the end of a plint for flexion, or lying prone on a plint for either extreme flexion or full extension. The hand is much better than any

FIG. 45. — The hold for flexion of the ankle and stretching the tendo Achillis.

machine, because it can give the important rotation movement of the leg upon the thigh in flexion so well insisted upon by Sir Robert Jones. At the end of each complete flexion of the knee, twist it in and out.

The hip can be extended, flexed, rotated, adducted, and abducted, with the patient supine on a plint, the ankle of the side to be moved being grasped by the operator by one hand, his other hand placed on the knee of the same leg, and the other knee drawn up to a right angle. The hips should be strapped in place. The movement of the thigh can then be made in the required direction.

Passive movement of the back can best be done with the patient strapped at the level of the trochanters prone to a plint, with the body projecting over the end, and supported by an assistant (leg lying); the trunk can then be flexed, extended, or rotated, on the fixed pelvis. Rotation can also be given from the position of sitting astride the plint by pressure on one shoulder and tension on another.

Passive movement of the neck in all directions should be done by the hands only, and with the greatest caution, the patient lying supine on the plint, with the head projecting over the end.

CHAPTER VII

ACTIVE MOVEMENT AND RËEDUCATION

ACTIVE MOVEMENTS. — Active movements are done free or with apparatus, and are for correction, reëducation, and the cultivation of strength and endurance.

Free movements of the joints need not be described in detail; they are simply a rehearsal of all the movements normal to each joint; but even where the limb is still in a splint, the patient may learn muscle dancing or twitching the muscles without moving the joint until they become strong enough to raise the dropped wrist from its dorsiflexed splint, or bend the stiffened knee and so reduce the time of splintage.

PRINCIPLES. — Apparatus is necessary to bridge the gap between free movement and the more complicated and skillful coördination of gymnastics and occupation, and it can be constructed so as to give a graduated and measurable load, to be increased as strength returns. Muscles work better against resistance than free, and the necessary resistance may be given by the hand, by friction, forming a brake on the turning of a wheel or handle, by stretching elastic cords, or by stretching or compressing springs. In these devices, it is difficult, or impossible, to measure accurately the work done. They vary at different stages of the movement, are uneven, and the patient quickly tire *and becomes* discouraged, because he cannot see a defin *and measurable* improvement. The best principle to u

the raising of graduated weights, either by a lever or by a rope and pulley. In the former, the weight is clamped on a lever at points indicated on a scale, the lengthening of the lever increasing the force necessary to raise it. This is the principle employed by Zander in most of his machines, which, however, are expensive, complicated, cumbrous, require much space, and need an engine to supply motive power for some of them. Appliances can be constructed to produce accurately the same effects at one tenth the cost, by making use of the weight and pulley.

Figure 46 shows diagrammatically an arrangement by which the direction of the resistance may be upward, downward, or from the side. Machines combining these three movements are called triplex, or triplicate machines, but, in addition to these, special devices are necessary for exercising certain joints. The following set of appliances are designed to combine simplicity, cheapness, and efficiency. They can be easily multiplied to any extent by a good carpenter and blacksmith who has the pattern before him.

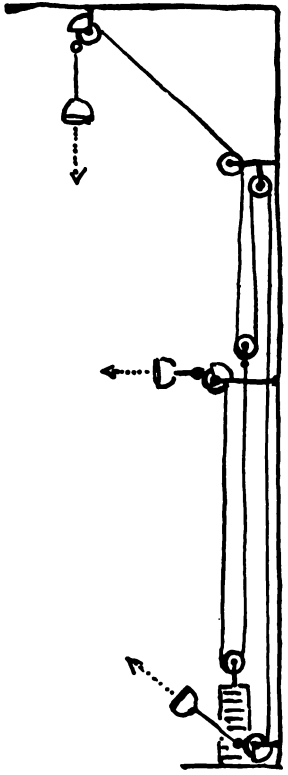

FIG. 46. — The triplicate pulley weight.

SEQUENCE. — *Their* use should *have a place in a* definite se*quence; treatment* begins with

the preparation of the limb or joint by electricity, radiant heat, or hot baths, then massage and passive movements, as already described, followed by active movement.

FIG. 47. — Protractors for measuring angles of movement in the shoulder, elbows, wrist, knee, and ankle. Hart House.

A mirror is of great value to teach accuracy and associate the feeling of the movement with its appearance.

MEASUREMENT. — Before beginning the reëducation of a joint, the range of movement should be carefully measured.

FIG. 49. — Small protractor for measuring the angle of flexion in fingers. Hart House. Toronto.

This is done by means of protractors of cardboard, or galvanized sheet iron, with the scale marked in degrees. The illustration shows the method of measuring movements of the shoulder forward and backward, the protractor being

set with zero perpendicular to the joint as checked by a plumb line. The movement in either direction is marked in degrees. The elbow, wrist, knee, and ankle are measured

FIG. 50. — Measuring strength of grip by the tycos sphygmomanometer. — F. W. Harvey.

by the second protractor made of galvanized iron strips, hinged, and with a scale pasted on to a side plate. Figure 49 shows a small one for the fingers.

Most of the appliances about to be described have protractors attached, so that the range of movement can be watched by the patient himself, during the exercise, and this additional incentive given him to use his best efforts. The measurement of ability to repeat movement will be in terms of weight raised and number of repetitions. The maximum strength of the grip can be taken conveniently by partly inflating the cuff of a tycos sphygmomanometer and noting the height to which the mercury is raised when the cuff is squeezed. This is quite as reliable as Amar's Bulb, and is better than the ordinary hand dynamometer.

The appliances are for two purposes, stretching and improving the strength. All the stretching movements are kept within the voluntary control of the patient, who can be trusted to desist before danger of lacerating firm adhesions is imminent. The appliances for improving the strength can be loaded with increasing weights as the power to lift them returns and the patient can be interested in watching the extent of each movement, as shown on the scale, in watching the rising weight as it is lifted, in calculating the total amount of work done in foot pounds, or in listening to and counting the clicks of the ratchet as the movement is made.

The operator should be seated opposite the patient in all hand and arm exercises on the table, Fig. 48, and should regulate the machines and amount of work done.

UPPER EXTREMITY. — 1. *Finger board.* — (*a*) For stretching contraction of the fingers, in flexion, and (*b*) for stretching abduction at the metacarpophalangeal joints.

(*a*) Extension of single fingers: The fingers are placed on *the board in mo*derate flexion, and the finger under treat*ment goes up the* stair, step by step. Note the last step *at which the finger* under treatment can be raised from th

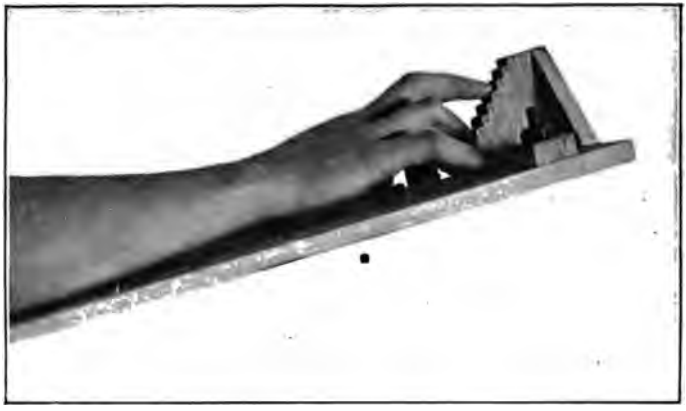

FIG. 51. — Finger board for stretching contractions and finger flexions. Hart House. Toronto.

step without assistance. Depress the hand to stretch still farther.

(*b*) Place the index finger against the peg at 1 and spread the second finger out, noting the farthest point at which

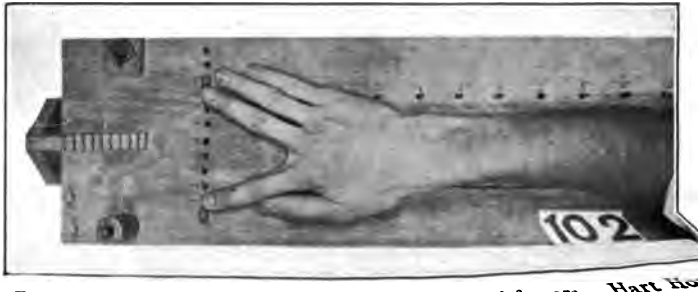

FIG. 52. — Finger board for stretching abduction of fingers. Hart Ho

it can touch the peg. Repeat with the second, third, and fourth.

Repeat each movement not more than five times.

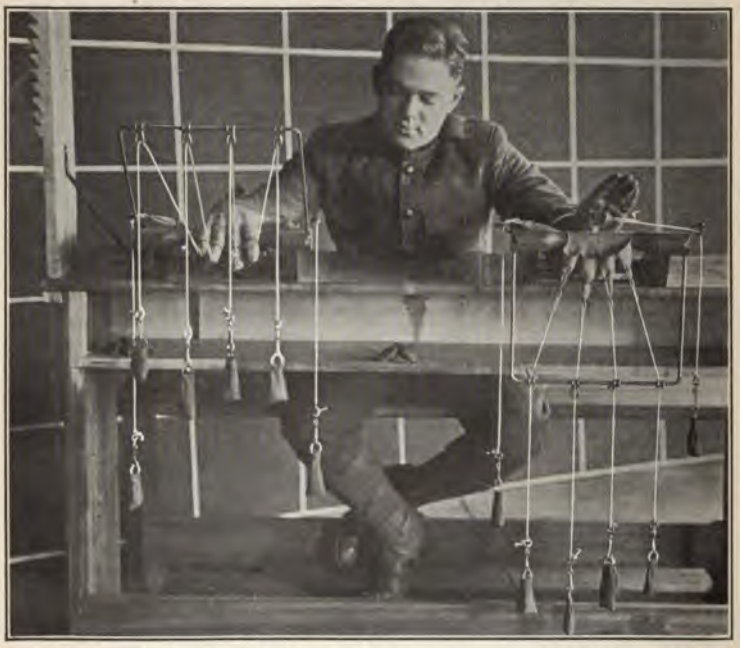

FIG. 53. — Pulley weights for exercising fingers in flexion and extension, right hand doing exercise 1, left hand with thumb attachment doing abduction.

The patient then moves to the next five appliances, the *operator sitting opposite.*

2. Finger pulleys. — For flexion and extension of the *fingers. Strap the* wrist and arm at the elbow, insert the

fingers into the glove stools and add weight until it can barely be lifted by the voluntary power of each finger. The weights are increased as improvement goes on, and the movements repeated up to the point of exhaustion.

1st exercise: High attachment. Flex metacarpophalangeal joints, keeping interphalangeal rigidly extended.

FIG. 54.

2d exercise: Horizontal attachment. Flex interphalangeal joints, keeping metacarpophalangeal joints extended.

FIG. 55.

3d exercise: Low attachment. Extend metacarpophalangeal joints, keeping inter-phalangeal extended.

4th exercise: Low attachment. Extend metacarpophalangeal and flex interphalangeal joints.

FIG. 56.

The operator seated opposite the patient should count the repetitions and encourage his efforts. Each exercise to be continued till movement shows flagging, and then stopped. The most convenient weights are shot bags, loaded to two ounces each, and attached by hooks. They can easily be made and repaired by the masseuse.

FIG. 57.

3. *Thumb ad- and abduction.* — Hand in pronation. Attach the stool on the radial side to the thumb for adduction.

1st exercise: Draw the thumb across the hand. Repeat the movement to exhaustion.

2d exercise: Attach the stool on the ulnar side to the thumb; draw the thumb out in abduction, Fig. 53. Repeat to exhaustion.

4. *Finger treadmill.* — For voluntary flexion of fingers. *Strap* the wrist and turn the wheel by flexing the fi

in turn till exhaustion of each finger. The amount of work done by a single finger can be calculated by using that finger only, and noting the weight, and the distance it is raised.

5. *Circumduction of wrist for stretching.* — Strap the wrist and forearm, grasp the handle, and turn the wheel about twenty revolutions each way. Move out the attachment to the farthest possible point compatible with the movement.

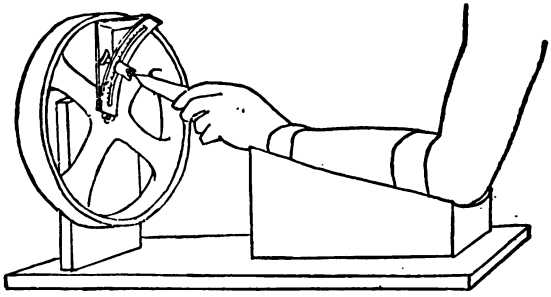

FIG. 58. — Circumduction of wrist.

The operator may assist at the most difficult part of the turn, by turning the crank.

6. *Ad- and abduction of wrist.* — Place the fingers under the straps on the hand board, strap down the wrist and forearm, ad- and abduct the hand, noting the range of movement on the protractor. The weights will vary for these two movements, which should be done separately.

7. *Flexion and extension of wrist.* — (1) Grasp the roller overhand and wind up the weight, without releasing the grasp and exerting the full range of movement. The scale *will measure the* range of the joint, and the weight and *distance multiplied* gives the total work done in foot *ounds.*

Precaution: see that the movement is done at the wrist only and not at the elbow or shoulder.

(2) Reverse the grasp and repeat for flexion.

FIG. 59. — Adduction and abduction of wrist. Note the scale to measure the angle of movement.

8. *Pronation and supination.* — Patient stands facing the machine and grasps the handle with the left hand, his left elbow joint flexed, his right forearm across his back, and h *hand grasping* his left arm above the elbow to prev *sideways* movement. Set weight and ratchet for supin

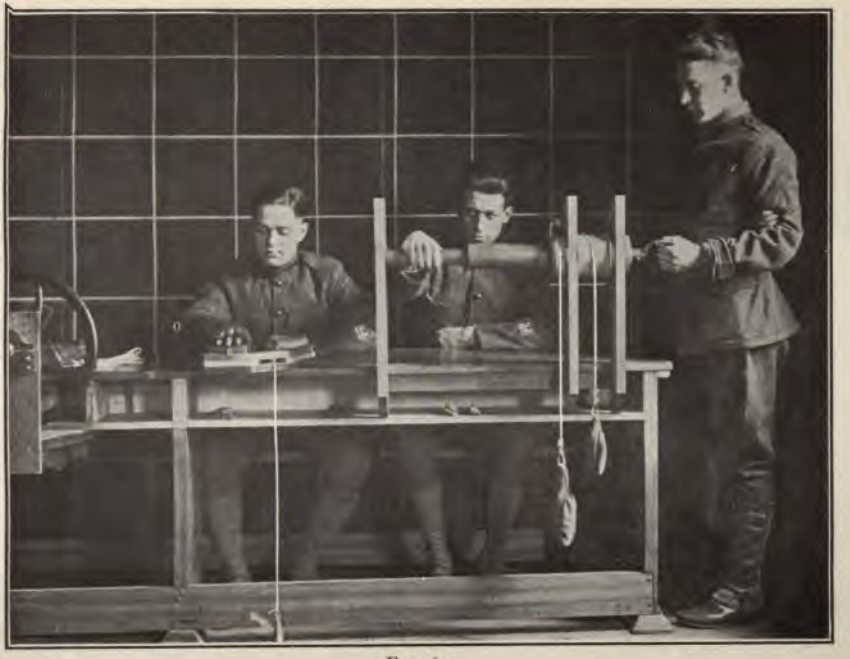

FIG. 60.

D, Wrist abduction in action. *E*, Beginning of wrist extension. *F*, Correct position of arm in pronation. See Fig. 48.

and turn, counting the clicks for each movement and noting the weight and the distance raised. The measurement of each movement will appear on the protractor. See that patient does not move his elbow out or in, or twist body. Reverse the ratchet and repeat for pronation.

9. *Flexion and extension at elbow.* — (1) The patient faces the triplicate machine, grasping the floor handle, the arm and cord in line. Flex and relax the forearm.

(2) Patient faces away from the machine, grasping the shoulder handle, the arm full flexed, the upper arm in line with the cord. Extend and relax the forearm. In both these exercises, the position of the upper arm must remain unchanged. If this is not done, the direction of the pull is changed.

FIG. 61

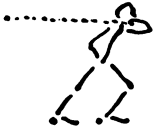

FIG. 62.

10. *Shoulder rotation.* — Grasp the floor handle, the elbow on a bracket, shoulder high, the forearm flexed to a right

FIG. 63

FIG. 64.

FIG. 65.

angle. Pull up with the hand, throughout whole range of shoulder movement without changing the height of the elbow or its angle of flexion.

11. *Flexion and extension of shoulder joint.* — (1) The patient stands with his back to the floor handle, the arm *down and straight.* Arm forward, raise, and lower. (2) Fac *to the floor* handle, draw the arm back, and lower to positi

12. *Ad- and abduction of the shoulder.* — The patient stands with the side to the triplicate machine, shoulder attachment, arm and cord in line. (1) Bring the arm forward across the chest. (2) Patient stands as in exercise 1, but

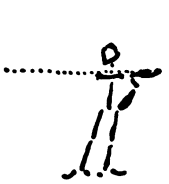
FIG. 66.

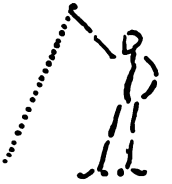
FIG. 67.


FIG. 68.


FIG. 69.

using the floor attachment. Bring the straight arm upward, and lower to position. (3) Patient stands with his side to the machine, overhead attachment, arm in line with the cord. Bring the arm downward and forward, then downward and backward, alternately. (4) The patient stands with the side from the machine, the arm across chest, grasping the shoulder attachment. Extend the forearm and arm, keeping them at the shoulder level.


FIG. 70.


FIG. 71.

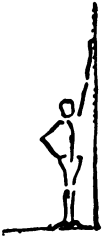
FIG. 72.

13. *Passive abduction of shoulder.* — Patient standing with the side to the creeping board, and the forearm rigidly extended. Climb up the board by the fingers with a straight arm, and note: 1st, the highest point at which the fingers can be lifted from the board *by the patient; 2d, the* level to which he can bring up his *arm, without bending* his elbow, Fig 72. Keep the body *rigid throughout,* not bent or twisted.

FIG. 73. Crumpling up a newspaper as an exercise for the hand.

FIG. 74. — Circumduction of the ankle. A stretching movement under the patient's control.

General movements that are of value in treating the muscles of the upper extremity are rolling up a ball of paper, throwing and catching balls of all sizes and weights, quoits, bowling, pingpong, crokinole, billiards, weaving, knitting, rope splicing, knots, the use of tools, like scissors, boring,

FIG. 75. — The inversion and eversion treads in use. Hart House.

hammering, modeling, painting, bookbinding, saddlery, and shoemaking.

LOWER EXTREMITY. — 14. *Circumduction of the ankle.* — The patient sits with his foot strapped in place. The range of movement is regulated by a thumb screw on the crank. The handle is turned by the patient or operator, for this *stretching* movement, which should precede the voluntary *active movements* of the ankle.

15. *Inversion and Eversion of Foot.* — (1) The patient walks on the inversion ridge, Fig. 75, a definite distance, with hand rail support.

(2) Ditto for eversion. Both (1) and (2) are stretching movements, and should precede (16).

(16) The patient is seated with the foot and leg strapped to the apparatus, Fig. 76. Evert the foot against the weight on the cord, and note the range of the movement on the protractor, and the total weight raised. Reverse this ratchet and repeat for inversion.

16. *Dorsiflexion of ankle.* — The patient sits or stands with his foot strapped to the footpiece, Fig. 77. Flex the ankle, raising the weight. The extent of the movement may be estimated by the number of clicks, the exact measurement noted on the protractor, and the total work done is easily calculated.

17. *Rotation of the knee.* — (*a*) The patient is seated with the foot strapped to the footpiece, and the leg against the brace, Fig. 78. He ad- or abducts the foot, rotating the knee, the extent of each movement being marked on the protractor. (*b*) The patient stands with the knee locked in extension as ad- or abduct the foot, Fig. 79. This movement measures hip rotation, if care be taken to keep the pelvis fixed. In either position, the movement of the flexed ankle is slight.

18. *Knee flexion and extension.* — Triplicate machine. Exercise 1. Face to the machine, strap the foot to the floor attachment. Movement: Flex the knee against resistance.

Exercise 2. Face from the machine, strap the foot to the floor attachment, the flexed leg and cord in the same line. Movement: Extend the knee against resistance.

19. *Hip ad- and abduction.* — Triplicate machine. Exercise 1. *Side to the* machine, the foot strapped to the floor attachment. *Movement*: Adduct the thigh, keeping the knee straight.

Fig. 76. — Eversion and inversion of ankle. Note the fixation of the leg, also the scale and pointer marking the angle of movement.

Fig. 77. — Exercise for foot drop. Note scale and pointer to record *angle of movements* on left side, and fixation of leg near the knee.

78. — Rotation of the knee, abduction of the foot. Note the scale and pointer in front of the foot for the measuring of the movement.

Fig. 79. — Rotation of hip — the knee extended and the pelvis fixed.

Exercise 2. Side from the machine, foot strapped to the floor attachment. Movement: Abduct the thigh, keeping the knee straight.

20. *Hip flexion and extension.* — Exercise 1. Face to the machine, foot strapped to the floor attachment. Movement: Extend the thigh with the leg stretched.

FIG. 80.

FIG. 81.

FIG. 82.

Exercise 2. Face from the machine, foot strapped to the floor attachment. Movement: Flex the thigh, keeping the knee straight.

21. *Thigh flexion, knee flexion, foot dorsiflexion.* — Patient steps through the rungs of a horizontal ladder with parallel bar arm rests. The ladder is made adjustable for

FIG. 83.

FIG. 84.

FIG. 85.

height at one end, and raised, to increase the movement required to raise the foot over each rung. This is especially useful for leg amputation cases, Fig. 86.

22. (9) *Thigh extension, knee extension, foot plantaflexion.* — The bicycle trainer with an increasing load of distance or friction.

General exercises: walking, hill climbing, dancing, kicking *a football or* hockey puck, balancing, skipping.

FIG. 86. — Amputated case practicing walking through the ladder to exercise the stump and teach control. Inversion and eversion treads also shown.

In the treatment of stumps, a sheath should be attached and the various pulley weight movements carried out as if the limb were intact.

AMPUTATIONS. — The reëducation of amputation cases begins with the preparation of the stump, and fitting of the

FIG. 87. The bicycle is arranged with adjustable pedals and resistance. It can also have motor for passive movement. Hart House.

artificial limb for comfort, and for the correct bearing of *the weight.* The patient should first learn to balance *which may* be made safe if he be suspended by a belt un

the arms, working from an overhead trolley or by grasping a bar. This inspires confidence, and prevents falls, especially in amputation at the thigh, where the balance is very difficult to get. The patient then progresses to the use of

FIG. 88. — Amputated case learning control on the balance beam.

sticks and progression on a smooth surface. He should discard crutches from the first. This is very important. He then learns to walk on a smooth, level surface with one stick only, to clear obstacles, like the ladder rungs already de-

scribed, and finally to walk through soft sand on uneven ground, up and down inclines, and over obstructions.

Lynn Thomas worked out an excellent plan at the Prince of Wales Hospital, for limbless men, at Cardiff, where, with the help of a landscape gardener, he constructed a sort of golf course, with suitable bunkers to illustrate the difficulties a limbless man would have to overcome. In the grounds, the walks were graded in slopes from one to twelve up to one in three, mounds of earth covered with shrubs were constructed, an artificial pond with a bridge to be crossed, a stile and gate, paths, built on a slant, tilted to right and to left. All such devices add interest to the process of perfecting the patients in the use of their artificial limbs, and supplement, and gradually replace, the more simple developmental work of the treatment room.

CHAPTER VIII

GYMNASTICS AND GAMES

THE object of gymnastics is to reëducate control, alertness, accuracy, speed, and strength in men who have lost them through neglect, injury, or the enforced idleness of hospital life:

The whole tendency of daily life in the hospital is to make men sluggish in mind and body. Discipline is relaxed, and their stamina, physical, mental, and moral, suffers in consequence. In a table of gymnastic exercises, the enforced discipline is not the least important part of the treatment in refitting them to take their place, either in military or civil life.

Gymnastic exercise should be considered as a part of the treatment, and should count as a parade. Patients should be classified according to their physical condition and requirements, and this classification given to the instructor.

Class I. Fit for duty. Able to take gymnastic tables 1 and 2, for convalescents, gymnastic games and marching, running, jumping, manual and vocational work.

Class II. Fit for light duty. Able to take gymnastic tables 1 and 2 for convalescents, walking, light games, no running or jumping, light vocational work.

Class III. Unfit for duty. Under individual treatment and unfit for class work or games. Each case to be judged on its merits.

Men who have lost an arm or hand, or who have a stiff knee or ankle, may be put in class II and go through such exercises as are within their power, standing fast when they come to an exercise beyond their power, and going on when the next movement is given. This is much better than excusing them, or putting them in classes by themselves, and

FIG. 89. — Slow balance exercise. Knee raising. Heaton Park. Note that three men are standing fast.

there should be constant and repeated inspections by the medical officer to see that no injury is done, and also that all exercises within their power are done.

Between five and ten per cent of hospital cases have some irregularity of heart action, and the treatment by electricity *and water* must be accompanied and gradually replaced by *progressive* exercise. These irritable hearts are frequer

but symptoms of general nervous disturbance or exhaustion. For them, exercise must begin with caution, and the load be increased with care. A rise in the pulse rate, persisting twenty-four hours, is the signal of overwork. At Heaton Park we found the greatest benefit from faradism, long-continued sedative baths every second day, followed by rest. On alternate days, these patients had gymnastic exercises as in tables 1 and 2, and slow walking of one half to one mile. As the need for men in the firing line was urgent at that time, they were then tried on a table of exercises, including running and jumping, and were also tested on a four-mile march. About thirty per cent, only, were able to stand it, and were passed as fit. The others showed a return of symptoms that remained latent under the lighter forms of exercise.

At the Hampstead Military Hospital for the heart, where only difficult cases were sent, about fourteen per cent were returned to the firing line, but nearly fifty per cent were made fit for some form of military work. Graduated exercises have shown at both places, not only that they cause improvement, but that they form admirable tests for estimating fitness for duty. It is often possible to state, after physical examination alone, that a man is unfit for duty, permanently, but it is never possible to decide, after physical examination alone, that a patient will be fit. The reaction to exercise forms the deciding test.

In sanataria for tuberculosis, a patient in whom the temperature has become normal is prepared for work by light exercise, principally walking, and, as soon as he has reached the stage when a half hour's walk twice a day causes no signs of relapse, he is allowed to take up the lighter forms of vocational training. In many men, suffering from the effects of irritating gas, the bronchitis and functional spasm, asthmatic in character, can be greatly benefited by slow, controlled breathing exercises.

Among the cases suffering from shell shock, exercises of

equilibrium present peculiar difficulties, and concentration, confidence, and courage can be well cultivated by the balance beam.

The period of debility following typhoid, dysentery, or other exhausting diseases will be greatly shortened by starting them early on progressive gymnastic exercise, sufficiently

FIG. 90. — Slow deep breathing exercises. Heaton Park.

vigorous to tone up the flabby muscles, without causing too great exhaustion.

The following two tables are compiled for use in hospitals and convalescent camps, the exercises being selected from the Aldershot tables for recruits. They cover, in a systematic way, the various regions of the body, with the thoroughness that characterizes the Swedish system, but quick and *jerky* movements, likely to strain an injured joint,

avoided. The progression is from partial to complete movements of the joints, *e.g.* from knee bending to full knee bending, and they contain no jumping or running exercise. In all cases of class I, and most cases of class II, they can be done in addition to treatment and vocational training, for their object is not only medical, but disciplinary, and it is of

FIG. 91. Balance exercises on the elevated beam. Heaton Park.

the utmost importance for the instructor to insist on exacting smartness and discipline. The time occupied should not exceed thirty minutes, as the attention of these patients soon tires, and, in many cases, the time should be considerably reduced. They should be done daily, the first table for two weeks, and the second for two weeks more. In the second *table, quickening* exercises and running games can be in*reasingly used, in* preparation for the free games and occu*tions into which the* patient is gradually initiated.

TABLE I. (*A*) INTRODUCTORY EXERCISES

Leg exercise.	(*a*) Feet close; (*b*) heels raise.
Neck exercise.	Head backward bend.
Arm exercise.	(*a*) Hips firm; (*b*) arms bend; (*c*) arms bend, arms upward stretch.
Trunk exercise.	Feet close, hips firm, trunk turning.
Leg exercise.	(*a*) Hips firm, foot sideways place; (*b*) feet astride place.

(*B*) GENERAL EXERCISES

Preparation for span bending.	Feet astride, arms upward stretch (taken free).
Balancing exercise.	Hips firm, knee raise.
Lateral exercise.	Feet close, hips firm, trunk bending sideways.
Abdominal exercise.	Hips firm, foot sideways place, trunk bending forwards.
Marching exercise.	Quick march; (later) on the toes march.

Practice class arrangements; in two ranks fall in, numbering, opening, and closing ranks.

(*C*) FINAL EXERCISES

Heels raise. Arms raising sideways.

The movements in this table should be done slowly and evenly. The instructor should avoid taking up much time with individual correction.

Emphasis should be placed on exactness and accuracy of *movement* and on mental alertness and promptness of re*sponse* to command.

TABLE II. (*A*) INTRODUCTORY EXERCISES

Leg exercise.	Hips firm, heels raising and knees bending (latter quickly).
Neck exercise.	Head bending backward (later head turning).
Arm exercise.	(*a*) Arms bend, one arm upward, one arm downward stretch; (*b*) arms bend, arms sideways stretch.
Trunk exercise.	Hips firm, foot sideways place, trunk turning.
Leg exercise.	(*a*) Feet close and full open; (*b*) hips firm, foot placing sideways.

(*B*) GENERAL EXERCISES

Preparation for span bending.	Feet astride, arms upward stretch, trunk backward bend (slight movement only).
Balancing exercise.	Hips firm, leg raising sideways; (later) backward and forward.
Lateral exercise.	Hips firm, foot sideways place, trunk bending sideways; (later) feet close, one arm upward and one arm downward, trunk bending sideways.
Abdominal exercise.	(*a*) On the hands down (by numbers); (*b*) on the back down (ground permitting); (later) with the leg raising.
Dorsal exercise.	Hips firm, foot sideways place, trunk forward bend, trunk downward bend.
Marching exercise.	Hips firm, with knee raising quick mark time.

(*C*) FINAL EXERCISES

Hips firm, foot sideways place, trunk turning. Heels *ise. Arms raising* sideways and upwards.

Patients unable to perform single movements should stand at ease.

The time taken by these tables should not occupy more than half of the hour set apart for exercise. The second half should be taken up with games and recreation, in which

FIG. 92. — High knee raising through wire entanglements at the double. Heaton Park.

discipline does not play a prominent part. These should consist of: 1. *Dancing* steps forward, backward, and to the sides, first taken to count, and then to music, and combined into series or dances. 2. *Tag games*, like three-deep, hunt the slipper, dodge ball. 3. *Relay races*, medicine ball passing, and message relays, and games for general development, such as golf, tennis, handball, basket ball, cricket, baseball, and swimming, for which may be substituted, in special cases, sports for development of the upper extremity, like billiards, *bowling*, quoits, or sports for developing lower extremities *like walking*, dancing, soccer, and cycling.

The following series shows a progression suitable for men who have to begin with the simplest movements, and feel their way to more difficult and complicated combinations. The instructor should always be on the watch to prevent men from undertaking movements which their disability might make dangerous.

1. Jumping and Dancing

Jumping the rope. Men in file. Two men take the ends of a rope eight feet long, and walk back, one on either side of the file, dragging it, the men jumping the rope as it passes. Repeat at the double.

Jumping the swinging rope. Men in a circle. The instructor, in the center, swings a shot bag, attached to a rope, the men jumping it, as it is let out, and the speed increased.

Fig. 93.

Dancing steps.

1. Heels together. Jump and point to left. Jump and point to the right.

2. Heels together. Jump and point to the left, turning the heel out. Jump and touch left heel. Jump and point to the right, heel out. Jump and touch right heel.

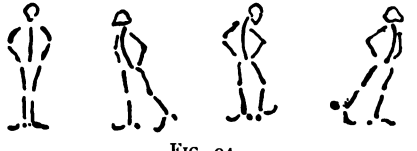

Fig. 94.

3. Heels together. Jump and touch left heel. Jump and bring left foot across right, pointing and touching the toe. Jump and kick to the left.

This is a simple series and excellent for balance, coördination, *and rhythm.* They should be done slowly at first, to command, *and then to* music.

Tag games.

These should be made progressive, beginning with squat tag, in which the player saves himself from being tagged by squatting in the full knee bend position. This may be varied by having him take the arms upward stretch position, and so secure a gymnastic effect, in addition. In cap tag, a cap or ball is passed from man to man, and the man who is "it" tries to tag the holder.

FIG. 95.

A simple and popular game is the Bogey Man. In this, a player, chosen as the Bogey Man, stands at one end of the yard, the other players stand at the opposite end. At a signal from him, they run, trying to pass him and reach the opposite end of the yard. He tags one or two, and they go with him to his side of the yard, and help him. The play is repeated until all the runners are caught by the Bogey Man and his helpers. The last one caught begins a new game.

A more highly organized form of this game is Prisoner's Base. In this, the play field is about thirty by seventy-five feet. A line across the field at each end marks the base of each team. At the right of each base a small space is marked off as a prison. The teams each consist of about ten players. The object of the game is to make prisoners of the players on the opposite team. Any player may be made a prisoner by an opposing player who left his base later than the first player did. For instance, a player of Team No. 1 leaves his base, and advances toward the base of Team No. 2. Having left his base, he may be tagged by any player on Team No. 2. When, therefore, an opposing player runs out to tag him, he *quickly* retreats to his own base before being tagged. If he is *tagged* before reaching his base, he is a prisoner, and is r

into the prison of Team No. 2. If, however, a player of his own team runs out to support him, and this new player (who left his base later than the pursuer) succeeds in tagging the player from Team No. 2, then this one is a prisoner, and is placed in the prison of Team No. 1.

When a prisoner is made, the captain of the team designates a player whose duty it is to guard the prison. The capture of three prisoners by one team wins the game. Prisoners may be freed when one of the players succeeds in tagging a prisoner without himself being tagged. If there are two prisoners, they may grasp hands and stretch out toward their team, thereby facilitating their release. If, then, the first one is tagged, they are both free.

Two circle games may be mentioned: The Beetle Is Out, and Dodge Ball.

In The Beetle Is Out, the players form a closed circle, shoulder to shoulder, facing inward, and having their hands, with palms open, behind their backs. One of the players is outside the circle. He carries a handkerchief with a knot tied in one end of it or a stuffed bag. Running around the outside of the circle, he puts the handkerchief into the hand of one of the players, if possible, without being noticed by the others. When the leader calls, "The beetle is out," the one having the handkerchief turns and strikes his right-hand neighbor on the back with the knot, the neighbor seeking to avoid the blows by running around the circle, until he regains his former place. The pursuer now starts around the circle, placing the handkerchief in another man's hand, and the game continues as before.

In Dodge Ball the men are divided into teams. Team A stands inside a circle forty-five feet in diameter, while Team B stands outside the circle, and attempts to throw a basket ball so as to strike one of the members of Team A. If any player of Team A is touched by the ball on the fly or bounce, a point is scored for the outer team. If a player is struck, he remains

in the game, and the game continues without interruption for three minutes, when the positions are reversed, and Team A throws the ball at Team B, and the team securing the greatest number of points during the game shall be the winner.

There are an infinite number of relay races, beginning with passing a medicine or basket ball, the players remaining in place, and going on to running and carrying relays. The following is a simple progression.

1. Men in file. The ball is passed back between the legs. The last man carries it forward and repeats. This is done by lines in competition.

2. Men in file. The ball is passed back over the head, and the last man carries it forward as before.

3. Men in file, all but three, A, B, and C, who are facing the file five yards away. At the signal, the first man runs with the ball, circles A, and gives him the ball. A circles B,

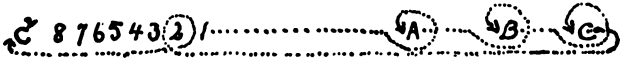

FIG. 96.

and gives him the ball. B circles C, and gives him the ball. He runs back to No. 2, circles him, and gives him the ball, and then takes his place in the rear.

4. Men in file except A, who is five yards in front of No. 1. A message is given confidentially to A in each file. A runs to No. 1 and brings him back, repeating the message on the run. No. 1 runs to No. 2, repeating the message as they run, and so on till the whole file is transferred to the other side.

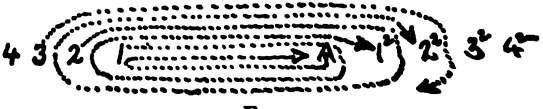

FIG. 97.

In addition to these difficult relays, are shuttl potato races, and other varieties, described in referen

The medicine ball is the most useful single pie paratus. It should be at least twelve inches in diam

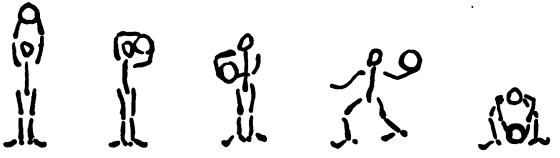

FIG. 98.

may be stuffed with anything to bring the weight u pounds or over. Passing relays can be arranged, ill the different methods of throwing and catching the ball, in a circle, in lines, or individually.

CHAPTER IX

TREATMENT BY OCCUPATION

TREATMENT by occupation differs from all other forı already described, in that the remedy is given in increasi doses with its patient's improvement. It is the final sta in his progress, to which all the others lead up.

In England and France, where great numbers of wound were thrown on the community at once, the country hous given by the public-spirited owners as auxiliary Red Cr Hospitals, too often became nurseries of the "hospital habit Men who came to them keen, well-disciplined, and ale too often lapsed in an atmosphere of indulgence and he worship into disorderly loafers, seeking a grievance in eve regulation made for their control. Their natural hunger f movement became lost in a progressive lethargy of mi and body. To combat this growing evil the Surgeon Ge eral, Sir Alfred Keogh established Command Depots, whe men were again put under strict discipline, but in whi treatment by physical therapy took the place of regu military training. A beginning was made by establishi workshops in them, at Tipperary, under Lieutenant-Colo Sims Woodhead, R.A.M.C., to give both treatment and cupation, and this plan was soon extended to others. the orthopedic centers, convalescent camps, and ma hospitals, notably at Roehampton, Netley, and Brigh *they are increasingly* used as part of the treatment; ar *Military* Hospitals Commissioners made occupation

apy and vocational training an integral part of the sche
of treatment in their chain of hospitals across Canada.

A distinction is frequently drawn between occupatio
therapy and vocational training. In the former, the mo
ments are given as treatment, and the work done is a s
ondary consideration. The patient saws wood because t
arm muscles can thus be contracted and relaxed a defin
number of times. It is really a gymnastic exercise do
with a saw.

In vocational training the object is to make a good b
by sawing the board in definite lengths, and the arm exerc
is secondary, though essential. It is a question of emphas
and it is impossible to draw a sharp line of distinction
most cases. Wherever the emphasis is laid, every man
benefited by occupation that keeps both his mind and bo
busy.

Hospital life gives plenty of time for introspection a
consequent depression, and to many a returned soldier t
acts as a poison, counteracting all attempts to bring him ba
to normal mental and physical condition. He becom
discouraged, and, worst of all, he becomes content to
with folded hands, bereft of ambition or purpose in life.

The purpose of occupational therapy is threefold:

1. Physical: To carry on the improvement in muscul
strength and control, obtained by treatment, and to app
it to the varied movements that the carpenter uses in ha
dling his tools or the gardener in cultivating his land.

2. Vocational: To give him an education directed
make him able to keep a set of books, or take a position
business where the handicap of a missing leg or an impair
arm will not be felt.

3. Moral, or self-disciplinary: To give courage to beg
life over again, sometimes in a new trade or business.
give him that self-respect that makes him want to stand
his own feet, and not be dependent on charity or the e

of others, to give him ambition to shake off the deade effects of his long period of enforced idleness, and to un take the necessary training for a trade or occupation f which he can make a living.

The direction of his treatment, with certain medical strictions, should be put in the hands of an officer, tra

FIG. 99. A class in bookkeeping. M. H. C. Hospital, Canada.

in vocational guidance, whose knowledge of various in tries and the training necessary for them would be bro into service. The patient should be examined by a bo of which this vocational officer is a member. His past tory should be obtained by questions about the kinds of *he has done*, his stability, as shown by the length *he has held* jobs, his reasons for changing, his pr

and dislikes, and his general intelligence. On a basis of the information obtained, combined with a review of his medical and military history, he should be advised as to the work best suited for his case. He would then register for the class decided upon and report just as he would for a parade, and he must be kept under military discipline, for his own sake.

FIG. 100. Mechanical workshops put at service of the M. H. C. by McGill University, Montreal, for returned soldiers.

The vocational officer must have instructors in charge of each branch taught. They may be got from the schools or colleges in the neighborhood, or in some cases, they may be *obtained from the* camp or hospital itself. They must be *made responsible to him* for their department, and carry it *on under his direction.* The courses given will, of necessity, *vary somewhat with* local conditions, but they include:

1. School work. The preparation of students for civil service examinations, bookkeeping, office work, stenography, and typewriting.

2. Draughting. The making of mechanical and architectural drawing and plans, lettering and painting, and modeling in plasteline or clay.

FIG. 101. — Repair shop for automobiles. M. H. C., Canada.

3. Printing and bookbinding. The use of tools and processes of binding books, lettering, tool work on leather, knotting and splicing, the processes of printing, and linotype.

4. Woodwork. The use of tools and the making of simple articles in wood, going on to making apparatus like artificial limbs, toy making, cabinet making, and allied trades of upholstery, varnishing, and polishing.

5. Mechanics. The use of tools for working in iron, brass, and tin. Plumbing and steam fitting.

6. Electricity. Wiring and the construction and repair of electrical apparatus.

7. Motors. Driving and repairs of motor cars.

FIG. 102. — The poultry farmers of Alberta, Canada.

8. Gardening. Lectures and practice in the care of flowers and truck gardens, each man being given his own patch of ground to cultivate.

9. Farming. Lectures and practice in poultry raising, beekeeping, cheese making, dairy and general farming, and fruit growing.

Hospitals should be affiliated with technical schools and *colleges, as* much as possible, so that their equipment may *be employed for teaching* purposes. In this way expert *eaching is easily obtained*, and the necessity of extensive *uipment is avoided*. For small institutions this is not

always possible, and a standard outfit should then be supplied for each trade taught.

If the experience of the Canadian authorities may be taken as a guide, less than ten per cent of all men require re-education in a new occupation. The majority of cases that come before the vocational officer suffer from medical,

FIG. 103. — Wounded Canadian soldiers returned to the land.

rather than surgical, disabilities. Rheumatism, chronic nephritis, neurasthenia, and tuberculosis are common, sometimes more than one being present.

Every case must be considered individually, but the amputations seem to form a class by themselves. They must first be trained to use the artificial limbs supplied to them *by the hospital*. They begin with the use of a sheath to *the stump* and exercises with pulley weights, to strengt

FIG. 104. — Light manual work for porch cases in a sanatorium for tuberculosis. M. H. C. Canada.

the weakened muscles, followed by practice with the leg or arm, as already described. The artificial hand or arm issued will depend on the occupation chosen. Better than the "Pince Universelle" of Amar or the German "Kellar Hook" is the cleverly designed "Salary Hook" or clamp

FIG. 105. — Amar's universal pincer.

issued by the Canadian government for heavy work; the Dorrance hook is valuable for light work, and the imitation hand is ornamental for Sunday. The Carns arm is seldom used except by an expert. When the trade to be taught is decided upon, he begins at once and takes an increas-

FIG. 106.

number of hours per day. In a roll kept of graduates from Roehampton and the London Polyclinic, legless men became electrical workers, moving picture operators, telephone workers, switchboard, attendants, motor engineers, munition workers, carpenters, clockmakers, and salesmen. Armless men became electrical workers, switchboa.d attendants, carpenters, storekeepers, laboratory assistants. The legless

FIG. 107. — Blind Irish Guardsman at work as a masseur. Heaton Park.

men averaged in wages about nine dollars a week; and the armless, about eight dollars. This shows the results of the special training available in one institution, but the range of instruction can be infinitely extended for both armless and legless men.

The blind have naturally received sympathy and attention. *Sir Arthur* Pearson, at St. Dunstans, has done pioneer work *They can be* taught boot repairing, mat making, net maki

basketry, simple carpentry, poultry farming, market gardening, salesmanship, and massage. The use of the dictaphone has opened typewriting to them, and there is little difficulty in obtaining work for them.

The vocational officer must be familiar with the prospects for placing men in their chosen occupations, and much of his work will be in this field through employers of labor and committees. The placing of men whose training is complete is best done by the vocational officer, through local civilian committees. Every effort must be made to induce men to undertake and follow up their training, by both rewards and penalties. The American government has organized this part of the reclamation work so that the man who refuses to take any form of training may have his pension reduced, whereas compliance with its regulation will give him a good living in addition to the very liberal insurance arrangements that have replaced the old pension system.

CHAPTER X

MASKING OF FACIAL DEFORMITY

AMONG the most distressing cases met with in military surgery are those in which the face has been so destroyed as to defy the best efforts of the plastic surgeon. The jagged fragment of a bursting shell will shear off a nose, an ear, or a part of a jaw, leaving the victim a permanent object of repulsion to others, and a grievous burden to himself. It is not to be wondered at that such men become victims of despondency, of melancholia, leading, in some cases, even to suicide.

After plastic surgery has done its best, and there remains nothing but a living gargoyle, much may still be done to make him presentable enough to mix freely with his fellows, and to earn his livelihood, without that constant humiliation to which his appearance would subject him.

The reclaiming of these maimed now passes out of the hands of the surgeon and the vocational officer, for here the sculptor must supplement their combined efforts by his skill in modeling masks so constructed, colored, and attached to the face as to successfully hide these hideous deformities. Many mediums have been tried; solid rubber, gutta percha, papier mâché, and plaster; but thin copper best fulfills the requirements, being pliable, strong, light, and durable. The wound must be soundly healed, so that no further shrinkage or other distortion will take place, before starting the sculptor on his part of the work.

The technique to be followed will vary slightly w preference of the operator. Captain Derwent Wood, . whose pioneer work in this branch of reconstruction 3d London General has earned such well-deserved

FIG. 108. — Destruction of the face from the bridge of nose to the lower jaw. (Case referred to author by Dr. W. L. Clark.)

models dire a plasteline although s procedure m disastrous tc less experien essentials technique a tained in t lowing proce

1. The de part of th and the su ing regions a cated with vaseline, tak to fill the hai in the eyeli the eyelash quick-settin ter of paris is and, when the consiste thick crean gently painted over the sound tissue, with a soft until the surface is covered. Care must be taken t a breathing space at the nose and mouth, and to s *the face is not* unnaturally drawn or wrinkled from n *ness. The plaster* is strengthened and thickened, *orms a sheet about* one inch in thickness. When *come set, as shown* by the heat, it is carefully dra

2. This mold, or negative, is well soaped with green so oiled, and a cast, or positive, is made, and trimmed to the quired shape and thickness. This serves as a record, original of the deformed face. Fig. 109.

3. From this model, a glue mold, or negative, is made.

4. Several casts may now be made from this mold, a colored by water color, to match the plasteline, which used in the next process.

FIG. 109. — Cast of the face of patient in Fig. 1

5. With the patient present, and by reference to photographs, the missing nose is modeled on one of these casts, great care being taken to imitate the surrounding surface texture and match it, especially at the edges. It is safer to model this in plasteline, over the plaster, rather than on a plasteline squeeze, as described later, if at all possible, beca the hard plaster prevents one making the possible erro going too deep in modeling a hollow. Where a missing has to be reproduced, another process is necessary at t stage.

6. A piece mold must be made from the cast (4). *prepared* with French chalk, and (6 A) a plasteline s *made.* The sculptor then opens the eye by modelin

FIG. 110. — Wax cast of remodeled parts in the same patient.

life (6 B), because the eye was closed during the taking of the original mold over the face.

7. A glue mold must then be made, from this plasteline cast of the remodeled eye, the sound one, and

8. A cast is made from this, as in 4, the process going on as in 5.

9. When the missing features have been modeled to the satisfaction of the sculptor and the patient, a glue mold is made of the restored face, from which

10. A cast in wax is made and worked on, or retouched, if necessary, Fig. 110.

11. The wax is now carefully coated with bronze powder, or plumbago, connected by copper wire with the cathode of a dry cell battery, and placed in a galvano deposit bath of sulphuric acid and sulphate of copper, between two copper plates connected with the anode. It is left there until a film of copper one thirty-second of an inch in thickness is deposited, a process lasting four or *five* hours. This is a process *in which many failures are likely to occur, until a good deal of experience is gained.*

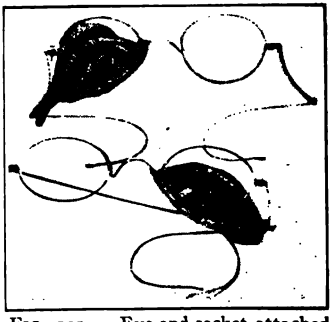

FIG. 111. — Eye and socket attached to glasses, showing hinges at temple and artificial lashes. Captain Derwent Wood.

12. The wax is now melted out, and the metal mask trimmed and tried on. Every advantage must be taken of natural lines and wrinkles of the face, to hide the borders. The nostril holes are opened, as well as the eye slit, which masks the missing eye.

13. The mask is then electroplated with silver by dipping in a solution of nitrate of silver, and

14. When the eye has to be replaced, the artificial glass eye is matched with the good eye, or, better still, a blank one

FIG. 112. — Mask for Fig. 108, colored and with glasses attached; mustache and whiskers in place. Patient in Fig. 108.

is painted to match, and then placed, and held in place, behind the open lids, by wire clips, like the setting of a jewel in a ring. This fitting requires great care and patience.

15. The mask is now given a coat of color, and the complexion is matched with great care, using oil colors with a wax medium. The success of this will depend entirely upon *the artistic skill* of the painter.

16. When this is completed, a pair of spectacle frame *with heavy* rims, are fitted on over the mask, and the

piece is riveted through the copper, or soldered to hold them in place. When a cheek is replaced, it may be necessary to have a pin from the spectacle frame to the mask, to give the gentle pressure necessary to keep it in place. Fig. 112.

17. Eyebrows can be made with real hair, or by painting them, and eyelashes are best made, in the experience of Derwent Wood, of tin foil, cut in thin strips, colored and soldered to the edge of the eyelid. They can also be set with real hair in a groove of the lid, and held by wax.

FIG. 113. — Mask in place on patient in Fig. 108.

When any discharge from the eye, nose, or salivary glands is present, dressings can be put within the mask, and renewed as required, for the mask is put on and off with the spectacles. In some cases, where the lower jaw is gone, this is very important, because the saliva is constantly dribbling, and, in these cases, it may be necessary to have an additional fastening for the mask about the neck, Fig. 114.

A lost ear can be modeled in plasteline, using its mate for comparison, and the process continued as already described, except that it must be attached by spirit gum to the face, as actors do with false whiskers, taking care to have a good

sized bearing surface. The mask will require to be recolored from time to time, as it wears, or becomes soiled, but it should last three or four months, with reasonable care, without this attention.

The illusion should be complete at a couple of yards' distance, except that where an eye is replaced, it cannot close and open, and a squint appears, unless the patient takes the precaution to look his friend full in the face. By means of these masks, horribly disfigured men have been able to accept and hold positions as chauffeurs, elevator attendants, clerks, and, in fact, any position involving appearance among their fellows, who are quite unconscious of the grisly gap present beneath this fair exterior. Timidity and self-consciousness disappear, as they find that they are no longer objects of repulsion to every onlooker. Self-respect returns, depression departs, and physical health follows the upward trend of their spirits.

FIG. 114. — Loss of lower part of face, mask held by glasses and neck ribbon. Derwent Wood.

The process, simple as it may sound, is really rather difficult, and can only be brought to a successful result by a high degree of sculptural skill, with infinite patience in trimming down, building up, altering, and adapting; with

many failures, before these strong metal films will cc to the remaining parts of the face, both in form and te The operator who is not a sculptor, and a sculptor of im tion, at that, will inevitably fail.

FIG. 115. — Loss of nose with mask in place. Case referred to the a by Dr. W. L. Clark.

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